SOCIETY OF ACTUARIES
Exam FET
Financial Economic Theory Exam (Finance/ERM/Investment)

Exam FET

MORNING SESSION

Date: Thursday, November 1, 2007
Time: 8:30 a.m. – 11:45 a.m.

INSTRUCTIONS TO CANDIDATES

General Instructions

1. This examination has a total of 120 points. It consists of a morning session (worth 60 points) and an afternoon session (worth 60 points).

   a) The morning session consists of 8 questions numbered 1 through 8.

   b) The afternoon session consists of 10 questions numbered 9 through 18.

   The points for each question are indicated at the beginning of the question. Questions 1 - 5 pertain to the Case Study, which is enclosed inside the front cover of this exam booklet.

2. Failure to stop writing after time is called will result in the disqualification of your answers or further disciplinary action.

3. While every attempt is made to avoid defective questions, sometimes they do occur. If you believe a question is defective, the supervisor or proctor cannot give you any guidance beyond the instructions on the exam booklet.

Written-Answer Instructions

1. Write your candidate number at the top of each sheet. Your name must not appear.

2. Write on only one side of a sheet. Start each question on a fresh sheet. On each sheet, write the number of the question that you are answering. Do not answer more than one question on a single sheet.

3. The answer should be confined to the question as set.

4. When you are asked to calculate, show all your work including any applicable formulas.

5. When you finish, insert all your written-answer sheets into the Essay Answer Envelope. Be sure to hand in all your answer sheets since they cannot be accepted later. Seal the envelope and write your candidate number in the space provided on the outside of the envelope. Check the appropriate box to indicate morning or afternoon session for Exam FET.

6. Be sure your written-answer envelope is signed because if it is not, your examination will not be graded.

Tournez le cahier d'examen pour la version française.

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Exam FET-Front Cover

Financial Economic Theory Formulae Sheet
May 2007

Megginson, Corporate Finance Theory

$$V_j = (S_j + D_j) = \frac{NOI_j}{\rho_k} \text{ for any firm j in class k}$$

$$k_j = \rho_c + \frac{(\rho_c - r)D_j}{S_j}$$

$$G_L = \left[1 - \frac{(1-\tau_c)(1-\tau_{ps})}{(1-\tau_{pd})}\right] D_L$$

$$V_L = V_U + PV\ tax\ shields - PV\ bankruptcy\ costs + PV\ agency\ costs\ of\ outside\ equity - PV\ agency\ cost\ of\ outside\ debt$$

$$\rho(t) = \left[\frac{d_j(t) + p_j(t+1) - p_j(t)}{p_j(t)}\right]$$

$$p_j(t) = \left[\frac{d_j(t) + p_j(t+1)}{1+\rho(t)}\right]$$

$$V(t) = \left[\frac{D(t) + n(t)p(t+1)}{1+\rho(t)}\right]$$

Hull , Options, Futures and Other Derivatives

$$F_0 = S_0 e^{rT}$$

$$F_0 = (S_0 - I)e^{rT}$$

$$F_0 = S_0 e^{(r-q)T}$$

$$f = (F_0 - K)e^{-rT}$$

$$f = S_0 - Ke^{-rT}$$

$$f = S_0 - I - Ke^{-rT}$$

$$f = S_0 e^{-qT} - Ke^{-rT}$$

$$F_0 = S_0 e^{(r-q)T}$$

$$F_0 = S_0 e^{(r-r_f)T}$$

$$F_0 = S_0 e^{rT}$$

$$F_0 = (S_0 + U)e^{rT}$$

$$F_0 = S_0 e^{(r+u)T}$$

$$F_0 \leq (S_0 + U)e^{rT}$$

$$F_0 \leq S_0 e^{(r+u)T}$$

$$F_0 = S_0 e^{(r+u-y)T}$$

$$F_0 = S_0 e^{cT}$$

$$F_0 = S_0 e^{(c-y)T}$$

$$F_0 = E(S_T)e^{(r-k)T}$$

$$\triangle z = \varepsilon\sqrt{\triangle t}$$

$$z(T) - z(0) = \sum_{i=1}^{N} \varepsilon_i \sqrt{\triangle t}$$

$$dx = adt + bdz$$

$$dx = a(x,t)dt + b(x,t)dz$$

$$S_T = S_0 e^{\mu T}$$

$$\frac{ds}{S} = \mu dt + \sigma dz$$

$$\Delta S = \mu S \triangle t + \sigma S \varepsilon \sqrt{\triangle t}$$

$$\frac{\Delta S}{S} \sim \phi(\mu \triangle t, \sigma\sqrt{\triangle t})$$

$$dG = (\frac{\partial G}{\partial x}a + \frac{\partial G}{\partial t} + \frac{1}{2}\frac{\partial^2 G}{\partial x^2}b^2)dt + \frac{\partial G}{\partial x}bdz$$

$$dS = \mu S dt + \sigma S dz$$

$$dG = (\frac{\partial G}{\partial S}\mu S + \frac{\partial G}{\partial t} + \frac{1}{2}\frac{\partial^2 G}{\partial S^2}\sigma^2 S^2)dt + \frac{\partial G}{\partial S}\sigma S dz$$

$$F = Se^{r(T-t)}$$

$$dF = (\mu - r)Fdt + \sigma F dz$$

$$dG = (\mu - \frac{\sigma^2}{2})dt + \sigma dz$$

$$c + Ke^{-rT} = p + S_0 e^{-qT}$$

$$c = S_0 e^{-qT} N(d_1) - Ke^{-rT} N(d_2)$$

$$p = Ke^{-rT} N(-d_2) - S_0 e^{-qT} N(-d_1)$$

$$d_1 = \frac{ln(S_0/K) + (r - q + \sigma^2/2)T}{\sigma\sqrt{T}}$$

$$d_2 = \frac{ln(S_0/K) + (r - q - \sigma^2/2)T}{\sigma\sqrt{T}} = d_1 - \sigma\sqrt{T}$$

$$dS = (r - q)Sdt + \sigma S dz$$

$$p = \frac{e^{(r-q)\Delta t} - d}{u - d}$$

$$\frac{\partial f}{\partial t} + \frac{1}{2}\frac{\partial^2 f}{\partial F^2}\sigma^2 F^2 = rf$$

$$H_F = e^{-rT} H_A$$

$$H_F = e^{-(r-q)T} H_A$$

$$H_F = e^{-(r-r_f)T} H_A$$

$$N(x) = \frac{1}{\sqrt{2\pi}} e^{\frac{-x^2}{2}}$$

$$\Delta\Pi = \Theta\Delta t + \frac{1}{2}\Gamma\Delta S^2$$

$$\Theta + rS\Delta + \frac{1}{2}\sigma^2 S^2 \Gamma = r\prod$$

$$\Delta = e^{-qT}\left[N(d_1) - 1\right]$$

$$Q_i(T|M) = N\left(\frac{N^{-1}\left[Q_i(T)\right] - a_i M}{\sqrt{1-a_i^2}}\right)$$

$$Q(T|M) = N\left(\frac{N^{-1}\left[Q(T)\right] - \sqrt{\rho}M}{\sqrt{1-\rho}}\right)$$

$$p(k,T|M) = \frac{N!}{(N-k)!k!}Q(T|M)^k\left[1 - Q(T|M)\right]^{N-k}$$

$$e^{-rT_1}\hat{E}\left[c\frac{S_1}{S_0}\right]$$

$$S_0 e^{-qT_2} M\left(a_1, b_1; \sqrt{T_1/T_2}\right) - K_2 e^{-rT_2} M\left(a_2, b_2; \sqrt{T_1/T_2}\right) - e^{-rT_1} K_1 N\left(a_2\right)$$

$$a_1 = \frac{ln\left(S_0/S^*\right) + \left(r - q + \sigma^2/2\right)T_1}{\sigma\sqrt{T_1}} \qquad a_2 = a_1 - \sigma\sqrt{T_1}$$

$$b_1 = \frac{ln\left(S_0/K_2\right) + \left(r - q + \sigma^2/2\right)T_2}{\sigma\sqrt{T_2}} \qquad b_2 = b_1 - \sigma\sqrt{T_2}$$

$$K_2 e^{-rT_2} M\left(-a_2, b_2; -\sqrt{T_1/T_2}\right) - S_0 e^{-qT_2} M\left(-a_1, b_1; -\sqrt{T_1/T_2}\right) + e^{-rT_1} K_1 N\left(-a_2\right)$$

$$K_2 e^{-rT_2} M\left(-a_2, -b_2; \sqrt{T_1/T_2}\right) - S_0 e^{-qT_2} M\left(-a_1, -b_1; \sqrt{T_1/T_2}\right) - e^{-rT_1} K_1 N\left(-a_2\right)$$

$$S_o e^{-qT_2} M\left(a_1, -b_1; -\sqrt{T_1/T_2}\right) - K_2 e^{-rT_2} M\left(a_2, -b_2; -\sqrt{T_1/T_2}\right) + e^{-rT_1} K_1 N\left(a_2\right)$$

$$\max\left(c, p\right) = c + e^{-q(T_2 - T_1)}\max\left(0, Ke^{-(r-q)(T_2 - T_1)} - S_1\right)$$

$$H \le K:\ c_{di} = S_0 e^{-qT}\left(H/S_0\right)^{2\lambda} N\left(y\right) - Ke^{-rT}\left(H/S_0\right)^{2\lambda - 2} N\left(y - \sigma\sqrt{T}\right)$$

$$\lambda = \frac{r - q + \sigma^2/2}{\sigma^2}$$

$$y = \frac{ln\left[H^2/(S_0K)\right]}{\sigma\sqrt{T}} + \lambda\sigma\sqrt{T}$$

$$c_{do} = c - c_{di}$$

$$H \geq K:\ c_{do} = S_0N(x_1)e^{-qT} - Ke^{-rT}N\left(x_1 - \sigma\sqrt{T}\right) - S_0e^{-qT}\left(H/S_0\right)^{2\lambda}N(y_1) + Ke^{-rT}\left(H/S_0\right)^{2\lambda-2}N\left(y_1 - \sigma\sqrt{T}\right)$$

$$c_{di} = c - c_{do}$$

$$x_1 = \frac{\ln\left(S_0/H\right)}{\sigma\sqrt{T}} + \lambda\sigma\sqrt{T}$$

$$y_1 = \frac{\ln\left(H/S_0\right)}{\sigma\sqrt{T}} + \lambda\sigma\sqrt{T}$$

$$H > K:\ c_{ui} = S_0N\left(x_1\right)e^{-qT} - Ke^{-rT}N\left(x_1 - \sigma\sqrt{T}\right) - S_0e^{-qT}\left(H/S_o\right)^{2\lambda}\left[N(-y) - N(-y_1)\right] + Ke^{-rT}\left(H/S_0\right)^{2\lambda-2}\left[N\left(-y + \sigma\sqrt{T}\right) - N\left(-y_1 + \sigma\sqrt{T}\right)\right]$$

$$c_{uo} = c - c_{ui}$$

$$H \geq K:\ p_{ui} = -S_0e^{-qT}\left(H/S_0\right)^{2\lambda}N(-y) + Ke^{-rT}\left(H/S_0\right)^{2\lambda-2}N\left(-y + \sigma\sqrt{T}\right)$$

$$p_{uo} = p - p_{ui}$$

$$H \leq K:\ p_{uo} = -S_0N(-x_1)e^{-qT} + Ke^{-rT}N\left(-x_1 + \sigma\sqrt{T}\right) + S_0e^{-qT}\left(H/S_0\right)^{2\lambda}N(-y_1) - Ke^{-rT}\left(H/S_0\right)^{2\lambda-2}N\left(-y_1 + \sigma\sqrt{T}\right)$$

$$p_{ui} = p - p_{uo}$$

$$H < K:\ p_{di} = -S_0N(-x_1)e^{-qT} + Ke^{-rT}N\left(-x_1 + \sigma\sqrt{T}\right) + S_0e^{-qT}\left(H/S_0\right)^{2\lambda}\left[N(y) - N(y_1)\right] - Ke^{-rT}\left(H/S_0\right)^{2\lambda-2}\left[N\left(y - \sigma\sqrt{T}\right) - N\left(y_1 - \sigma\sqrt{T}\right)\right]$$

$$p_{do} = p - p_{di}$$

$$c_{ELB} = S_0e^{-qT}N(a_1) - S_0e^{-qT}\frac{\sigma^2}{2(r-q)}N(-a_1) - S_{\min}e^{-rT}\left(N(a_2) - \frac{\sigma^2}{2(r-q)}e^{Y_1}N(-a_3)\right)$$

$$a_1 = \frac{ln\left(S_0/S_{\min}\right) + \left(r - q + \sigma^2/2\right)T}{\sigma\sqrt{T}}$$

$$a_2 = a_1 - \sigma\sqrt{T}$$

$$a_3 = \frac{ln(S_0/S_{\min}) + (-r + q + \sigma^2/2)T}{\sigma\sqrt{T}}$$

$$Y_1 = -\frac{2(r - q - \sigma^2/2)ln(S_0/S_{\min})}{\sigma^2}$$

$$p_{ELB} = S_{\max}e^{-rT}\left(N(b_1) - \frac{\sigma^2}{2(r-q)}e^{Y_2}N(-b_3)\right) + S_0e^{-qT}\frac{\sigma^2}{2(r-q)}N(-b_2) - S_oe^{-qT}N(b_2)$$

$$b_1 = \frac{ln(S_{\max}/S_o) + (-r + q + \sigma^2/2)T}{\sigma\sqrt{T}}$$

$$b_2 = b_1 - \sigma\sqrt{T}$$

$$b_3 = \frac{ln(S_{\max}/S_0) + (r - q - \sigma^2/2)T}{\sigma\sqrt{T}}$$

$$Y_2 = -\frac{2(r - q - \sigma^2/2)ln(S_{\max}/S_0)}{\sigma^2}$$

$$\max(0, S_T - S_\tau) + (S_\tau - K)$$

$$r - \frac{1}{2}\left(r - q - \frac{\sigma^2}{6}\right) = \frac{1}{2}\left(r + q + \frac{\sigma^2}{6}\right)$$

$$M_1 = \frac{e^{(r-q)T} - 1}{(r-q)T}S_0$$

$$M_2 = \frac{2e^{(2(r-q)+\sigma^2)T}S_0^2}{(r - q + \sigma^2)(2r - 2q + \sigma^2)T^2} + \frac{2S_0^2}{(r-q)T^2}\left(\frac{1}{2(r-q)+\sigma^2} - \frac{e^{(r-q)T}}{r - q + \sigma^2}\right)$$

$$\sigma^2 = \frac{1}{T}\ln\left(\frac{M_2}{M_1^2}\right)$$

$$V_oe^{-qv^T}N(d_1) - U_0e^{-qu^T}N(d_2)$$

$$d_1 = \frac{ln(V_o/U_o) + (q_U - q_V + \hat{\sigma}^2/2)I}{\hat{\sigma}\sqrt{T}} \qquad d_2 = d_1 - \hat{\sigma}\sqrt{T}$$

$$\hat{\sigma} = \sqrt{\sigma_U^2 + \sigma_V^2 - 2\rho\sigma_U\sigma_V}$$

$$\lambda = \frac{\rho}{\sigma_m}(\mu_m - r)$$

$$d\ln S = \left(\theta(t) - a\ln S\right)dt + \sigma dz$$

Babbel and Fabozzi , Investment Management for Insurers

$$D(t,I) = \frac{1}{e^{s(t,T)\times(T-t)}} = \frac{1}{e^{\phi(T-t)\times(T-t)}} E\left[\frac{1}{e^{\int_t^T r_s ds}}\right]$$

$$r_s^* = r_s + \phi(s-t) + \phi(s-t)\times(s-t)$$

$$D(t,T) = \frac{1}{e^{s(t,T)\times(T-t)}} = E\left[\frac{1}{e^{\int_t^T (r_s + \phi(T-t))ds}}\right] = E\left[\frac{1}{e^{\int_t^T r_s^* ds}}\right]$$

$$D_S = (D_A - D_L)\frac{A}{S} + D_L$$

$$P(j) \approx P(i)\left[1 - D(i)(j-i) + \frac{1}{2}C(i)(j-i)^2\right]$$

$$D(i) = \frac{-P'(i)}{P(i)} \qquad C(i) = \frac{P''(i)}{P(i)}$$

$$P'(i) \approx \frac{P(i+\Delta t) - P(i-\Delta t)}{2\Delta t}$$

$$P''(i) \approx \frac{P(i+\Delta t) - 2P(i) + P(i-\Delta t)}{(\Delta i)^2}$$

$$D = \frac{\sum t c_t v^{mt+1}}{p} \qquad C = \frac{\sum t(t+\frac{1}{m})c_t v^{mt+2}}{p}$$

$$P(j) = P(i)\exp\left[-\int_i^j D(s)ds\right]$$

$$D(j) \approx D(i) + \left[D^2(i) - C(i)\right](j-i)$$

$$P(j) \approx P(i)\exp\left[-D(i)(j-i)\right]$$

$$S(j) \approx S(i)\left[1+C^S(j-i)^2\right]$$

$$D^S(j) \approx -C^S(i)(j-i)$$

$$di_t = \mu(t,i_t)dt + \sigma(t,i_t)dz_t$$

$$i_T = i_0 + \int_0^T \mu(t,i_t)dt + \int_0^T \sigma(t,i_t)dz_t$$

$$\frac{dP_t}{P_t} = (\frac{\partial_t P_t}{P_t} - D_t\mu_t + \frac{1}{2}C_t\sigma_t^2)dt - D_t\sigma_t dz_t$$

$$\frac{dP_t}{P_t} = (i_t - (T-t)\mu_t + \frac{1}{2}(T-t)^2\sigma_t^2)dt - (T-t)\sigma_t dz_t$$

$$dD_t = (\partial_t D_t + (D_t^2 - C_t)\mu_t + \frac{1}{2}\left[D_t(D_t^2 - C_t) - \partial_t C_t\right]\sigma_t^2)dt + (D_t^2 - C_t)\sigma_t dz_t$$

$$P(j) = P(i)\left[1 - D(i)\bullet\Delta i + \frac{1}{2}\Delta i^T C(i)\Delta\right]$$

$$D_k(i) = \frac{-\partial_k P(i)}{P(i)} \qquad C_{kl}(i) = \frac{-\partial_{kl} P(i)}{P(i)}$$

$$\partial_k P(i) \approx \frac{\left[P(i+\Delta iE_k) - P(i-\Delta iE_k)\right]}{\left[2\Delta i\right]}$$

$$\partial_{kl} P(i) \approx \frac{\left[P(i+\Delta i(E_j+E_k)) - P(i-\Delta i(E_l-E_k)) - P(i+\Delta i(E_k-E_l)) + P(i-\Delta i(E_k+E_l))\right]}{\left[2\Delta i\right]^2}$$

$$\frac{\Delta P}{P} = -\sum_{i=1}^{n} D_i \Delta F_i$$

$$D_i = -\frac{1}{P}\frac{\partial P}{\partial F_i}$$

$$\Delta P = A - \sum_{i=1}^{n} D_i X_i + \frac{1}{2}\sum_{i=1}^{n} C_i X_i^2 + Y$$

$$D_i = -\frac{P_i - P_i'}{2\Delta F_i}$$

$$C_i = \frac{P_i + P_i^{"} - 2P}{(\Delta F_i)^2}$$

$$A = \mu - \frac{1}{2}\sum_{i=1}^{n} C_i \sigma_i^2$$

$$\mu = E\Delta P$$

$$\sigma^2 = Var(\Delta P) = \sum_{i=1}^{n}\sum_{j=1}^{n} D_i D_j \sigma_{ij} + \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} C_i C_j \sigma_{ij}^2 + s^2$$

$$\mu_3 = E(\Delta P - \mu)^3 = 3\sum_{i=1}^{n}\sum_{j=1}^{n}\sum_{k=1}^{n} D_i D_j C_k \sigma_{ik}\sigma_{jk} + \sum_{i=1}^{n}\sum_{j=1}^{n}\sum_{k=1}^{n} C_i C_j C_k \sigma_{ij}\sigma_{jk}\sigma_{ki}$$

Chew, The New Corporate Finance

$$G_L = \left[1 - \frac{(1-t_c)(1-t_{ps})}{(1-t_{pb})}\right] B_L$$

Trigeorgis, Real Options

$$NPV = \sum_{t=1}^{T} \frac{\alpha_t E(c_t)}{(1+r_1)\ldots(1+r_t)} - I$$

$$E(r_j) = r + \beta_j \left[E(r_m) - r\right]$$

$$Expanded\ (strategic)\ net\ present\ value\ (NPV^*) = \left[Direct\ (passive)\ NPV + strategic\ value\right] + flexibility\ value$$

$$\frac{d\pi_A}{dK_A} = \frac{\partial \pi_A}{\partial K_A} + \frac{\partial \pi_A}{\partial \alpha_B}\frac{d\alpha^* B}{dK_A}$$

Rasmusen, Games and Information, An Introduction to Game Theory

best response: $\pi_i(s_i^*, s_{-i}) \geq \pi_i(s_i', s_{-i}) \forall s_i' \neq s_i^*$

dominated strategy: $\pi_i(s_i^d, s_{-i}) < \pi_i(s_i, s_{-i}) \forall s_{-i}$

dominant strategy: $\pi_i(s_i^*, s_{-i}) > \pi_i(s_i, s_{-i}) \forall s_{-i} \forall s_i' \neq s_i^*$

weakly dominated:
$\pi_i(s_i^{"}, s_{-i}) \geq \pi_i(s_i, s_{-i}) \forall s_{-i}$ *and* $\pi_i(s_i^{*}, s_{-i}) > \pi_i(s_i, s_{-i})$ *for some* s_{-i}

Nash equilibrium: $\forall i,\ \pi_i(s_i^{*}, s_{-i}^{*}) \geq \pi_i(s_i, s_{-i}^{*}) \forall s_i$

pure strategy: $s_i : \omega_i \rightarrow a_i$

mixed strategy: $s_i : \omega_i \rightarrow m(a_i)$ *where* $m \geq 0 \quad \int_{A_i} m(a_i)da_i = 1$

completely mixed: $m > 0$

minimax strategies: $\min imize_{s_{-i}} \max imize_{s_i} \pi_i(s_i, s_{-i})$

maximin strategies: $\max imize_{s_i} \min imize_{s_{-i}} \pi_i(s_i, s_{-i})$

evolutionarily stable strategy (ESS): $\pi\ (s^{*}, s^{*}) > \pi\ (s\ , s^{*})$ *or*

$$(a)\ \pi(s^{*}, s^{*}) = \pi(s\ , s^{*})\ \textit{and}\ (b)\ \pi(s^{*}, s\ ) > \pi(s\ , s^{'})$$

epsilon equilibrium: $\forall i,\ \pi_i(s_i^{*}, s_{-i}^{*}) \geq \pi_i(s_i, s_{-i}^{*}) - \varepsilon, \forall s_i \in S_i$

FET-100-07

$$PV = \frac{1}{(1 + r_{risk\ free})}\left[(1 - p^{D})100 + p^{D}RV\right]$$

$$Default\ prob \approx 1 - \frac{1}{\left[1 + \frac{S_{market}}{1 - \frac{RV}{100}}\right]^{t}}$$

Counterparty Credit Charge (CCC):

$$ccc = (100\% - RR_{CP}) \sum_{t=t_0}^{tN} \sum_{R=Def}^{AAA} prob_{joint}\left\{CP_{in\ default} RE_{rating=R}\right\} OP_{rating=R}$$

FET-101-07 None

FET-102-07

$$F = \sum_i \max\left(S_{i0}, S_{iT}\right) = \sum_i S_{iT} + \sum_i \max\left(0, S_{i0} - S_{iT}\right)$$

$$F = \max\left(\sum_i S_{i0}, \sum_i S_{iT}\right) = \sum_i S_{iT} + \max\left(0, \sum_i \left(S_{i0} - S_{iT}\right)\right)$$

FET-103-07 None

FET-104-07

$$\sigma_t^2 = \alpha_0 + \alpha_1 (Y_{t-1} - \mu)^2 + \beta \sigma_{t-1}^2$$

$$F_{t^+} = F_{t^-}(1-m) = F_{(t-1)}(1-m)\frac{S_t}{S_{t-1}}$$

$$F_{(t+u)^+} = F_t \frac{S_{t+u}(1-m)^u}{S_t}$$

$$M_t = \left(F_{t^-}\right) m_c = m_c F_{0^-} \frac{s_t (1-m)^{t-1}}{S_0} \qquad \textit{errata sheet}$$

$$C_n = -_n p_x^\tau (G - F_n)^+$$

$$C_t = -_t p_x^\tau M_t^d + {}_{t-1|1}q_x^\omega \left(G - F_t\right)^+ \qquad \textit{note: M should have d superscript}$$

$$C_t = -_t p_x^\tau F_0 - S_t(1-m)^t m_d + {}_{t-1|1}q_x^d \left(G - F_0 - S_t(1-m)^t\right)^+ \qquad \textit{errata sheet}$$

$$C_t = {}_{t-1|1}q_x^d \left(G_r - F_t\right)^+ - {}_t p_x^\tau M_t \quad \textit{where} \quad n_r < t < n_{r+1}$$

$$C_{n_r} = {}_{n_r-1|1}q_x^d \left(G_r - F_{n_r^-}\right)^+ + {}_{n_r} p_x^\tau \left(G_r - F_{n_r^-}\right)^+ - {}_{n_r} p_x^\tau M_{n_r}$$

$$\log(1+i_t)\left|\rho_t^y = \mu_{\rho_t^y}^y + \phi_{\rho_t^y}^y \left(\log(1+i_{t-1}) - \mu_{\rho_t^y}^y\right) + \sigma_{\rho_t^y}^y \varepsilon_t\right.$$

$$H_0 = B(0,n)\mathrm{E}_Q\left[F_n (g a_{65}(n) - 1)^+\right]$$

$$H_0 = F_0 \mathrm{E}_Q\left[\left(\frac{g a_{65}^d(0,n)}{B(0,n)} - 1\right)^+\right]$$

$$H_t = F_t\left\{g a_{65}(t)\Phi(d_1(t)) - \Phi(d_2(t))\right\} \text{ where}$$

$$d_1(t) = \frac{\log(g a_{65}(t)) + \sigma_y^2 (n-t)/2}{\sigma_y \sqrt{n-t}} \quad \text{and} \quad d_2(t) = d_1(t) - \sigma_y \sqrt{n-t}$$

FET-105-07 None

FET-106-07

$$dS = \mu S dt + \sigma S dZ$$

$$dr = \mu(r,t) r dt + r\sigma dZ$$

$$\sigma(t,T) = \frac{\sigma\left(\frac{\Delta r(t,T)}{r(t,T)}\right)}{\sqrt{\Delta t}}$$

$$\sigma(t,T) = \frac{\sigma(\Delta r(t,T))}{\sqrt{\Delta t}}$$

$$dr = a(b-r)dt + \sigma\sqrt{r}dZ$$

$$dr = a(b-r)dt + \sigma dZ \text{ , (a>0)}$$

$$dr = a_1 + b_1(l-r)dt + r\sigma_1 dZ$$

$$dl = (a_2 + b_2 r + c_2 l)dt + l\sigma_2 dW$$

$$dV = M(t,r)dt + \Omega(t,r)dZ$$

$$M(t,r) = V_t + \mu(t,r)V_r + \frac{1}{2}\sigma(t,r)^2 V_{rr}$$

$$\Omega(t,r) = \sigma(t,r)V_r$$

$$d\Pi = (M_1(t,r) - \Delta M_2(t,r))dt + (\Omega_1(t,r) - \Delta\Omega_2(t,r))dZ$$

$$d\Pi = r\Pi dt$$

$$V_t + (\mu(t,r) - \lambda(t,r)\sigma(t,r))V_r + \frac{1}{2}\sigma(t,r)^2 V_{rr} - rV = 0$$

$$P_i^n(1) = 2\left[\frac{P(n+1)}{P(n)}\right]\frac{\delta^i}{(1+\delta^n)} \qquad \delta = e^{-2r(1)\sigma}$$

$$P_i^n(T) = \frac{1}{2}P_i^n(1)\left\{P_i^{n+1}(T-1) + P_{i+1}^{n+1}(T-1)\right\}$$

$$r_i^n(1) = \ln\frac{P(n)}{P(n+1)} + \ln(\frac{1}{2}(\delta^{\frac{-n}{2}} + \delta^{\frac{n}{2}})) + (\frac{n}{2} - i)\ln\delta$$

Note: Typo in text $r_i^n(1)1=$ either way will receive full credit.

$$dr = (f'(0,t)+\sigma^2 t)dt + \sigma dz$$

$$r(n)\sigma^s(n) = \frac{-\frac{1}{2}\ln\left[\delta(n)\delta(n-1)\ldots\delta(1)\right]}{n}$$

$$P_i^n(1) = \left[\frac{P(n+1)}{P(n)}\right]\left[\frac{(1+\delta_{n-1}\delta_{n-2}..\delta_1)..(1+\delta_{n-1})2}{(1+\delta_n..\delta_1)..(1+\delta_n)}\right]\delta_n^i$$

$$dr = (f'(0,t)+\sigma^2(t)t + \tfrac{\sigma'(t)}{\sigma(t)}\left[r(t)-f(0,t)\right])dt + \sigma(t)dZ$$

$$P_{ij}^n(1) = \frac{P(n+1)}{P(n)}\frac{(1+\delta_{n-1}^1..\delta_1^1)(1+\delta_{n-1}^1..\delta_2^1)..(1+\delta_{n+1}^1)2}{(1+\delta_n^1..\delta_1^1)\ (1+\delta_n^1\delta_{n-1}^1)(1+\delta_n^1)}\times$$

$$\frac{(1+\delta_{n-1}^2..\delta_1^2)(1+\delta_{n-1}^2..\delta_2^2)..(1+\delta_{n-1}^2)2}{(1+\delta_n^2..\delta_1^2)(1+\delta_n^2..\delta_2^2)..(1+\delta_n^2)}(\delta_n^1)^i(\delta_n^2)^j$$

$$dr = \left\{f'(t)+\left|\sigma(t)\right|^2 t + \frac{\left|\sigma'(t)\right|\cos\phi(t)}{\left|\sigma(t)\right|\cos\theta(t)}\left[r-f(t)\right]\right\}dt + \sigma(t)dW$$

$$d\ln r = (\theta(t) - \frac{\sigma'(t)}{\sigma(t)}\ln r)dt + \sigma(t)dW$$

$$dr(t) = (\alpha(t)-\beta r(t))dt + \sigma dW(t)$$

$$\text{where } \alpha(t) = \frac{\partial f(0,t)}{\partial T^*} + \beta f(0,t) + \frac{\sigma^2}{2\beta}(1-e^{-2\beta t})$$

$$dr = \left[\theta(t)+\mu-ar\right]dt + \sigma_1 dW$$

$$du = -budt + \sigma_2 dZ$$

$$dP(t,T^*) = r(t)P(t,T^*)dt + \sigma^P(t,T^*)P(t,T^*)dZ$$

$$df(t,T^*) = \sigma^P(t,T^*)\sigma_{T^*}^P(t,T^*)dt - \sigma_{T^*}^P(t,T^*)dZ$$

$$dP(t,T^*) = r(t)P(t,T^*)dt + \sigma(T^*-t)P(t,T^*)dZ(t,T^*)$$

$$L(t,T^*) = \frac{1}{\Delta}\left(\frac{P(t,T^*)}{P(t,T^*+\Delta)}-1\right)$$

$$dL(t,T^*) = L(t,T^*)\left[\sum_{j=t}^{N^*}\frac{L(t,j\Delta)\Delta}{1+L(t,j\Delta)\Delta}\Lambda(T^*-j\Delta)\Lambda(T^*-t)dt+\Lambda(T^*-t)dZ\right]$$

$$L(k,j+1) = L(k,j)\exp\left[\left(\sum_{i=j+1}^{k}\frac{L(i,j)\Delta}{1+L(i,j)\Delta}\Lambda_{i-j-1}\Lambda_{k-j-1}-\frac{\Lambda_{k-j-1}^2}{2}\right)\Delta+\Lambda_{k-j-1}\sqrt{\Delta}\tilde{Z}\right]$$

Where $\sigma_j^2 j = \sum_{i=1}^{j}\Lambda_{j-i}^2$

caplet $C_k = L\delta_k P(t_{k+1})\left[F_k N(d_1) - R_x N(d_2)\right]$

$$\text{where } d_1 = \frac{\ln\left[\frac{F_k}{R_X}\right]+\sigma_k^2\frac{t_k}{2}}{\sigma_k\sqrt{t_k}} \qquad d_2 = d_1-\sigma_k\sqrt{t_k}$$

$$\text{swaption} = \sum_{i=1}^{mn}\frac{L}{m}P(t_i)\left[R_F N(d_1)-R_X N(d_2)\right] = L^* A\left[R_F N(d_1)-R_X N(d_2)\right]$$

$$\text{where } A = \frac{1}{m}\sum_{i=1}^{mn}P(t_i) \quad 1\le i\le mn$$

$$P(k+1,j) = P(k,j)\exp\left[\left(r(k)-\frac{\sigma^2(j-k)}{2}\right)\Delta+\sigma(j-k)\sqrt{\Delta}Z(j-k)\right]$$

$$\sigma^*(T^*-t) = (a+b(T^*-t))\exp(-c(T^*-t))+d$$

$$L(k,j+1) = L(k,j)\exp\left[\left(\sum_{i=j+1}^{k}\frac{L(i,j)\Delta}{1+L(i,j)\Delta}\Lambda_{i-j-1}\Lambda_{k-j-1}-\frac{\Lambda_{k-j-1}^2}{2}\right)\Delta+\Lambda_{k-j-1}\sqrt{\Delta}Z\right]$$

$$P(T^*,i;T) = \frac{P(T^*+T)}{P(T^*)}\cdot 2\cdot\frac{\prod_{t=T}^{T+T''-1}h(t)}{\prod_{t=1}^{T^*-1}h(t)}\delta^{Ti} \quad \text{where } h(t)=\frac{1}{1+\delta^t}$$

FET-107-07 None

FET-108-07

$$V(E) = V(F)-V(D) = V(F)-D_{DF}+P(V(F),D) = C(V(F),D)$$

$$V^*(F) = S + D(1+\frac{m}{n})$$

$$V_R(E) = -C + V_R(F) - D + P\{V_R(F), D\} = -C + V_R - D + P_R$$
$$V_N(E) = V_N(F) - D + P\{V_N(F), D\} = V_N - D + P_N$$

$$face\,value + principal\,forgiven - default\,put\,assu\min g\,reinvestment = D - (P_N - P_R - NPV) - P_R$$
$$= (D - P_N - B - NPV) + B = value\,of\,regular\,debt + saving\,in\,bankruptcy\cos t$$

FET-109-07

$$RBC = \frac{1}{2}\left[C_0 + C_{4a} + \left[(C_1 + C_{3a})^2 + C_2^2 + C_{3b}^2 + C_{4b}^2\right]^{\frac{1}{2}}\right]$$

FET-110-07

market value of surplus = market value of assets – market of liabilities
= PV (assets cash flows) – PV (liabilities cash flows)
= PV of net cash flows

Total return = income + realized returns + unrealized returns

FET-111-07 None

FET-112-07 None

FET-113-07

$$\sigma_Y^2 = \sum_{i=1}^{n}\sigma_{x_i}^2 = \sum_{i=1}^{n}\omega_i^2\sigma_i^2$$

$$MCaR = k\sigma_r = k\sqrt{\sum_{i=1}^{n}\omega_i^2\sigma_i^2} = \sqrt{\sum_{i=1}^{n}k^2\omega_i^2\sigma_i^2} = \sqrt{\sum_{i=1}^{n}DCaR_i^2}$$

$$Total\,CaR = \sqrt{\sum_{i=1}^{n}CaR_i^2 + \sum_{i=1}^{n}\sum_{i\neq j}CaR_iCaR_j\rho_{ij}}$$

FET-114-07

$$NPV = (1-d)V\{S^+\} - (C-\mu) - (1+m)V\{S^-\}$$
$$= \mu - (dV\{S^+\} + mV\{S^-\})$$

$$V\{S^+\} = \frac{\sigma(n(z) + zN(z))}{(1+r)}$$

$$V\{S^-\} = \frac{\sigma(n(z) - zN(-z))}{(1+r)}$$

FET-115-07 None

FET-116-07 None

FET-117-07 None

FET-118-07

$$\left[N + kLe^{-sT}\right]e^{sT} = L + \left(kLe^{-sT}\right)e^{rT}$$

$$N = Le^{-sT}\left[1 - k + ke^{(r-s)T}\right]$$

$$V(R) = \sum_{t=1}^{T} Le^{-st} = L\frac{d(1-d^T)}{1-d} = Le^{-sT}\frac{e^{sT}-1}{e^s-1} \quad \text{where } d = e^{-s}$$

$$D(R) = -\frac{1}{V(R)}\frac{dV(R)}{ds} \quad d(R) = \frac{e^s}{e^s-1} - \frac{T}{e^{sT}-1}$$

$$D(A) = \frac{(1+k)V(R)D(R)}{V(A)}$$

$$V(FL) = Le^{-sT}\frac{p}{e^s-p}\frac{e^{ns}-p^n}{e^{ns}} = Le^{-sT}\sum_{t=1}^{n} p^t e^{-st}$$

$$V(FP) = N\frac{p}{e^s-p}\frac{e^{ns}-p^n}{e^{ns}}$$

$$V(FR) = (N - Le^{-sT})\frac{p}{e^s-p}\frac{e^{ns}-p^n}{e^{ns}}$$

$$D(A) = \frac{(1+k)V(R)D(R)}{V(A)} - \frac{V(FR)D(FR)}{V(A)}$$

$$D(FL) = \frac{e^s}{e^s-p} - \frac{np^n}{e^{ns}-p^n} + T$$

$$D(N_f) = \frac{e^s}{e^s-p} - \frac{np^n}{e^{ns}-p^n}$$

$$D(N_v) = \frac{e^s}{e^s-p} - \frac{np^n}{e^{ns}-p^n} + T\left[1 + \frac{(1-b)ke^{aT+(b-1)sT}}{1-k+ke^{aT+(b-1)sT}}\right]$$

$$D(FP)=\frac{e^s}{e^s-p}-\frac{np^n}{e^{ns}-p^n}+vT\left[1+\frac{(1-b)ke^{aT+(b-1)sT}}{1-k+ke^{aT+(b-1)sT}}\right]$$

$$D(FR)=\frac{V(FP)D(FP)-V(FL)D(FL)}{V(FP)-V(FL)}=\frac{p}{e^s-p}\frac{e^{ns}-p^n}{e^{ns}}+T\left[\frac{vNM-Le^{-sT}}{N-Le^{-sT}}\right]$$

$$where \quad M=1+\frac{(1-b)ke^{aT+(b-1)sT}}{1-k+ke^{aT+(b-1)sT}}$$

$$\frac{1}{N}\frac{dN}{ds}=-vTM$$

$$\frac{1}{N_c}\frac{dN_c}{ds}=-wTM$$

$$\frac{1}{N}\frac{dN_{rel}}{ds}=\frac{1}{N}\left[\frac{dN}{ds}-\frac{dN_c}{s}\right]$$

$$\frac{1}{V(FR)}\frac{dV(FR)}{dp}=\left[\frac{e^s}{p(e^s-p)}-\frac{np^n}{p(e^{ns}-p^n)}\right]$$

$$Dp(FR)=q(w-v)TM\left[\frac{e^s}{e^s-p}-\frac{np^n}{e^{ns}-p^n}\right]$$

$$D_{tot}(FR)=D_s(FR)+D_p(FR)=\left[\frac{p}{e^s-p}\frac{e^{ns}-p^n}{e^{ns}}\right]+T\left[\frac{vNM-Le^{-sT}}{N-Le^{-sT}}\right]+q(w-v)TM\left[\frac{e^s}{e^s-p}-\frac{np^n}{e^{ns}-p^n}\right]$$

FET-119-07

$$P^*-P=-P\,D(i)\,d(i)$$

FET-120-07

$$\text{maximize } U(P)=ExpRet(P)-\frac{\left[ExpRisk(P)\right]^2}{rt}-\frac{\left[ExpTE(P)\right]^2}{tet}$$

FET-121-07 None

FET-122-07

$$spending_t = smoothing\ rate\left[spending_{t-1}(1+\inf lation_{t-1})\right]+$$
$$(1-smoothing\ rate)(spending\ rate * beginning\ market\ value_{t-1})$$

FET-123-07

$$\min\left(E\left[DK\left(\alpha+\frac{1}{\alpha}(P-\beta)^2\right)\right]\right)$$

$$\beta=\frac{E[DP]}{E[D]}$$

$$\alpha=\frac{1}{E[D]}\sqrt{E\left[DP^2\right]E[D]-E[DP]^2}$$

$$D_t = D_0\exp\left\{\frac{1}{2\sigma^2}\left(\mu^2-\left(r+\frac{\sigma^2}{2}\right)^2\right)t+\frac{1}{\sigma^2}\left(r-\mu-\frac{\sigma^2}{2}\right)X_t\right\}$$

$$D_t = D_0\left(\frac{S_t}{S_0}\right)^{-\alpha}\exp\left\{-r(1-\alpha)t+\frac{1}{2}\sigma^2\alpha(\alpha-1)t\right\}$$

$$S_t = S_0e^{X_t}, X_t \sim N\left(\left(r-\frac{\sigma^2}{2}\right)(T-t),\sigma^2(T-t)\right)$$

FET-124-07

$$R_{S(L)}=\left(\frac{A_0}{L_0}R_A\right)-R_L$$

$$R_A = R_f+\beta_A r_Q+\alpha$$

$$\sigma_A^2=\beta_A\sigma_Q^2+\omega_A^2$$

$$\max(U_S)=R_S-\lambda\sigma_S^2$$

$$\max(U_S)=\left(\frac{A_0}{L_0}-1\right)R_F+\beta_S\mu_Q-\lambda_\beta\beta_S^2\sigma_Q^2+\left(\frac{A_0}{L_0}\alpha_A-\alpha_L\right)-\lambda_\omega\left[\left(\frac{A_0}{L_0}\right)^2\omega_A^2-2\frac{A_0}{L_0}\omega_A\omega_L+\omega_L^2\right]$$

$$P_{TIPS}=\frac{F}{(1+r)^T}$$

$$P_{EQUITY} = \sum_{t=0}^{\infty} \frac{Dvd_0 (1+g_r)^t}{(1+r)^t}$$

FET-125-07 None

FET-126-07 None

FET-127-07 None

FET-128-07 None

FET-129-07 None

FET-130-07 None

FET-131-07 None

FET-132-07

$$\sigma_j^2 w_j^{\ 2} + \sum_{\substack{i=1 \\ i \neq j}}^{n} \sigma_j \sigma_i w_i w_j \rho_{ij}$$

$$\sum_{i=1}^{n} \sigma_i^2 w_i^2 + \sum_{j=1}^{n} \sum_{\substack{i=1 \\ i \neq j}}^{n} \sigma_j \sigma_i w_i w_j \rho_{ij}$$

FET-133-07 None

FET-134-07 None

FET-135-07 None

FET-136-07 None

FET-137-07 None

FET-138-07

$$c = \int_{W^*}^{\infty} f(w)\, dw$$

$$VAR = W_0 \times \alpha\sigma\sqrt{\Delta t}$$

$$se(\hat{q}) = \sqrt{\frac{c(1-c)}{T\, f(q)^2}}$$

FET-139-07 None

$$dr_t = a\left[b - r_t\right]dt + \sigma dW_t$$

$$\frac{dP(t,T)}{P(t,T)} = r_t dt - \sigma_P\left(T-t\right)dW_t$$

$$\sigma_P\left(t,T\right) = \frac{\sigma}{a}\left(1 - e^{-a(T-t)}\right)$$

$$P(t,T) = G(T-t)\ \exp\left(-H\left(T-t\right)r_t\right)$$

$$H\left(T-t\right) = \frac{1-e^{-a(T-t)}}{a}$$

$$G(T-t) = \exp\left[\left(\frac{\sigma^2}{2a^2} - b\right)\left(T-t\right) + \left(b - \frac{\sigma^2}{a^2}\right)H\left(T-t\right) + \frac{\sigma^2}{4a^2}H\left(2\left(T-t\right)\right)\right]$$

$$\frac{dA_t}{A_t} = \mu dt + \sigma_A\left[\rho dW_t + \sqrt{1-\rho^2}\ dZ_t\right]$$

$$B_T = \max\left[0, \delta\left(\frac{L_0}{A_0}\left(A_T - A_0\right) - \left(L_T^* - L_0\right)\right)\right] = \delta\alpha\max\left[0, A_T - \frac{L_T^*}{\alpha}\right]$$

$$L_T^* = L_0 e^{rT}$$

$$L_T = L_T^* + B_T = \delta\alpha A_T + \left(1-\delta\right)L_T^*$$

$$E_T = \max\left[0, A_T - L_T^*\right] - \delta\alpha\max\left[0, A_T - \frac{L_T^*}{\alpha}\right]$$

$$E_t = C_E\left(A_t, L_T^*\right) - \delta\alpha C_E\left(A_t, \frac{L_T^*}{\alpha}\right)$$

Note: study note has a typo; full marks for either.

$$C_E\left(A_t, L_T^*\right) = A_t N(d_1) - P(t,T) L_T^* N(d_2)$$

$$C_E\left(A_t, \frac{L_T^*}{\alpha}\right) = A_t N(d_3) - P(t,T)\frac{L_T^*}{\alpha} N(d_4)$$

$$d_1 = \frac{\ln A_t / P(t,T) L_T^* + \bar{\sigma}(t,T)^2 (T-t)/2}{\bar{\sigma}(t,T)\sqrt{(T-t)}} = d_2 + \bar{\sigma}(t,T)\sqrt{(T-t)}$$

$$d_3 = \frac{\ln \alpha A_t / P(t,T) L_T^* + \bar{\sigma}(t,T)^2 (T-t)/2}{\bar{\sigma}(t,T)\sqrt{(T-t)}} = d_4 + \bar{\sigma}(t,T)\sqrt{(T-t)}$$

$$\bar{\sigma}(t,T)^2 = \frac{1}{T-t}\int_t^T \left[\left(\rho\sigma_A + \sigma_P(u,T)\right)^2 + \left(1-\rho^2\right)\sigma_A{}^2\right] du$$

$$E_t = A_t\left[N(d_1) - \delta\alpha N(d_3)\right] - P(t,T) L_T^*\left[N(d_2) - \delta N(d_4)\right]$$

$$L_t = L_T^* P(t,T) - P_E\left(A_t, L_T^*\right) + \delta\alpha C_E\left(A_t, \frac{L_T^*}{\alpha}\right)$$

$$P_E\left(A_t, L_T^*\right) = -A_t N(-d_1) + P(t,T) L_T^* N(-d_2)$$

$$L_t = A_t\left[N(-d_1) + \delta\alpha N(d_3)\right] + P(t,T) L_T^*\left[N(d_2) - \delta N(d_4)\right]$$

$$(1-\alpha) A_0 = C_E\left(A_0, L_T^*\right) - \delta\alpha C_E\left(A_0, \frac{L_T^*}{\alpha}\right)$$

$$\delta = \frac{C_E\left(A_0, L_T^*\right) - (1-\alpha) A_0}{\alpha C_E\left(A_0, \frac{L_T^*}{\alpha}\right)}$$

$$\eta_P(t,T) = H(T-t)$$

$$\eta_A(t,T) = -\frac{\rho\sigma_A}{\sigma}$$

$$\eta_L(t,T) = \eta_P(t,T) - \frac{A_t}{L_t}\left[\eta_P(t,T) - \eta_A\right]\left[N(-d_1) + \delta\alpha N(d_3)\right]$$

$$D_L = \frac{\ln\left(1 - a\eta_L(0,T)\right)}{a}$$

$$\eta_A(t,T) = \frac{E_t}{A_t}\eta_E(t,T) + \frac{L_t}{A_t}\eta_L(t,T)$$

$$\eta_E(t,T) = \eta_P(t,T) - \frac{A_t}{E_t}\left[\eta_P(t,T) - \eta_A\right]\left[N(d_1) - \delta\alpha N(d_3)\right]$$

$$\hat{P}(t,T,\hat{r}_t) = G(T-t)\exp\left(-H(T-t)\hat{r}_t\right)$$

$$\hat{A}_t(\hat{r}_t) = A_t \exp\left(-\eta_A(\hat{r}_t - r_t)\right)$$

AAA Monograph: Fair Valuation of Insurance Liabilities Principles and Methods

$$r_L = r_A - e\left(\frac{r_E}{1-t} - r_A\right)$$

$$MVM_t = L_{t-1}\left(r_f - r_L\right)$$

RBC Phase 2 – AAA Paper C3 Phase 2 Report (pages 1-18) None

RSA Vol. 22 #3 "Strategic Investment Policy Formulation and Implementation" None

CIA Guidance Notes: An Overview of an Investment Policy Statement in an A/L Management Context None

CIA Educational Note: Liquidity Risk Management None

RSA Vol. 27 #2 "Liquidity Modeling and Management" None

NOVEMBER 2007

EXAM FET

Financial Economic Theory

CASE STUDY

FET morning

INVESTMENT CASE STUDY

LifeCo

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BACKGROUND AND HISTORY

LifeCo is a multinational stock life insurance company and has general account assets totaling $5 billion supporting three main lines of business: Individual Life and Annuity, Institutional Pensions and Group Benefits. Its assets are internally segmented in eleven major portfolios defined below. Each portfolio is fully integrated in the accounting databases with full income statements and balance sheets produced monthly. LifeCo has recently implemented guidelines for Asset Liability Management and is in the process of identifying strategies for mitigating its exposure to interest rate and other risks.

LINES OF BUSINESS

Individual Life and Annuity

- Traditional Life
- Non-Traditional Life
- Accumulation Annuity
- Equity-Linked GIC
- Separate Account for Variable Annuity and Variable UL

Institutional Pensions

- Payout Annuity
- GIC
- Separate Account for Institutional GICs

Group Benefits

- Long Term Disability
- Other A&H

Surplus Account

- Surplus Capital

DESCRIPTION OF LIABILITIES

Individual Life and Annuity

Traditional Life includes all non-interest-sensitive individual life products and is predominantly comprised of non-par term and whole life. Guaranteed interest on whole life policies ranges from 3% to 6%. Policyholders can take out policy loans against any cash surrender value. A maximum loan rate of 7% exists on older policies. The duration of the traditional life liability cash flows tends to be fairly long. It has been difficult to find assets with suitable characteristics to effectively match these liabilities The liabilities in the traditional life segment are supported by $300 million of assets

Non-Traditional Life consists entirely of universal life. Universal life policyholders can direct their investments into a number of interest bearing or equity-linked accounts.

Interest bearing accounts generally credit a portfolio average rate and have a minimum credited interest guarantee of 4% across the board. Because LifeCo incurs significant costs associated with the acquisition of this business, even though the present value of future fund profits exceeds the present value of all future benefits and expenses, it will not have the hard assets to invest at issue in order to match the interest rate exposure of the liabilities. This situation creates significant reinvestment rate risk. To further complicate matters, the embedded options present in universal life mean that the liability cash flows will not be fixed and will vary with interest rates. The liabilities in the non-traditional life segment are supported by $400 million of assets.

Accumulation Annuity contains all individual flexible and single premium deferred annuities. Assets total $1.5 billion. Most funds are available for withdrawal at a book value basis. Surrender charges decline to 0% over a 5-7 year period. Minimum guarantees are generally in the 3-4% range but there is a $500 million block of annuities that have a 5% minimum guarantee. This latter block was sold with a 6% cliff surrender charge and will be reaching the end of the surrender charge period in the next year (i.e. the surrender charge will go from 6% to 0%). There is also a $250 million block of MVA (market value adjusted) annuities included in this segment. The Accumulation Annuity portfolio has been the subject of much modeling scrutiny over the years to better understand the product profitability and risk profile. Actuaries at LifeCo have internally flagged each asset purchase in the portfolio to a particular product in order to support a more detailed level of analysis.

Equity Linked GICs offer the return of principal after five years, plus 75% of the percentage increase of the S&P 500 total return index over that five year period (if positive). As at December 31st:

- assets total $55 million
- remaining term to maturity of GICs is 4.5 years
- current percentage increase of the S&P 500 total return index since issue is 6%
- volatility of the S&P 500 index equals 18%
- S&P 500 total return index is expected to grow at 15% / year

Variable Annuities include a guaranteed minimum death benefit, which, upon death of the policyholder, will pay the maximum of the current account value and the deposits accumulated at 5%. Upon surrender, the market value less surrender charges is paid. The benefit is reduced dollar-for-dollar on partial surrenders. For example, assume a policy holder elects to take a $10 partial surrender of the $100 Account Value when the GMDB is $110 after the surrender charge wears off. As a result of the partial withdrawal, the Account Value would be reduced by $10 to $90 and the GMDB would also be reduced by $10 to $100. Therefore, the dollar amount of the GMDB exposure in excess of the Account Value remains constant, but increases as a percentage of the Account Value.

Separate Accounts for Variable Annuity and Variable Universal Life assets are invested in various externally managed mutual funds. Policyholders may transfer between the funds offered, make new deposits, and withdraw money, subject to a surrender charge.

Institutional Pensions

Payout Annuity contains pension buyout annuities in both immediate and deferred status, supplementary contracts arising from life and annuity contracts, and structured settlement annuities. This segment was established to hold intermediate to long-term income payment streams that may or may not include life contingencies. Structured settlement annuities contain standard and substandard life contingent annuities, non-life contingent streams and some COLA (cost-of-living adjustment) escalators. Assets total $700 million.

Guaranteed Investment Contract (GIC) includes both single deposit and window GIC's. This segment holds $1.5 billion of assets. $200 million of the portfolio consists of funding agreements that are putable with 60 days notice. $100 million of the portfolio consists of floating rate funding agreements, payable in Euro's, which mature over the next 5 years. The remaining liabilities are benefit-sensitive contracts with institutional pension plans, which mature over the next 5 years.

Separate Account Institutional GIC offers single deposit and window GICs to larger institutional clients. For accounts larger than $150 million, the company will offer to set up a separate portfolio for one client, with its own asset allocation targets. Administrative fees are reduced for the commingled accounts, which are available to clients with at least $25 million. While the institutional client owns the market value of its share in the separate account, the individual participants receive interest credited to the book value of their individual accounts. LifeCo annually resets the crediting rates, so that the market value gains and losses in the commingled account are shared with participants. The general formula used to set the credited rate is as follows:

Credited rate
- = *Market yield of separate account*
- - *Administration fees*
- + *(MV separate account – BV individual accounts) / (Duration of separate account)*

In addition, LifeCo guarantees that the market value of each separate account will never be less than 80% of the book value of the individual accounts associated with it. LifeCo does not offer synthetic GICs.

Group Benefits

Group Long-Term Disability pays up to 70% of an employee's salary prior to the disability claim. Premiums are paid through payroll deduction. Premium rates are guaranteed for 2 years. Claims incurred stay with LifeCo even if the employer changes its insurance carrier for new business. The current product provides "own occupation" benefits generally for two years from the date of incurral, after which payments continue only if the claimant is unable to work at all. LifeCo offers rehabilitative services and counseling where it may be effective, usually through the first four years of a claim. Claim runoff is such that reserves at claim duration 10 are expected to be about 10% of the reserve at date of incurral. There is no cash surrender benefit to either individual

claimants or group policyholders. The claim liabilities and unearned premium in respect of the group LTD segment are backed by $500 million of assets.

Other A&H includes short-term group medical, dental, and term life products. These products are sold through the same group benefits general agents who distribute the company's LTD product. The company competes on strong underwriting and customer service. The products are repriced at least annually to meet profitability targets. While investment margins are material, they are seen as independent of underwriting margins. Earned premium to surplus leverage is low, at about 4/1. The claim reserves and unearned premium in respect of the other A&H segment are backed by $130.8 million of assets.

Surplus Account contains the surplus capital. The Surplus Account is managed to maximize total rate of return growth over time subject to a series of constraints related to liquidity, bond ratings and operating income versus surplus income concerns. Company guidelines require an asset mix of 10-70% in equities, 0-50% in real estate, and 5-90% in bonds. The target asset mix is 50% equities, 35% real estate, and 15% public and private bonds.

RATINGS OF COMPANY

Mud & Poor's (M&P) Rating Agency uses the following rating categories:

AAA, AA, A, BBB, BB, B, etc

LifeCo is currently rated "AA-". One year ago, M&P raised concerns about LifeCo and placed the company under ratings review. LifeCo was not downgraded at that time.

M&P's report at that time included the following rationale for the review:

Capital:	LifeCo's capital position of 3.6% of assets is weak relative to the other insurers rated "AA-".
Liquidity:	LifeCo's liquidity position appears weak. Given that the GICs will mature over the next few years and that a significant portion of the new sales are directed to separate account products, the company would appear to have a higher than usual liquidity risk.
Credit Risk:	LifeCo is exposed to C1 risk because of its investments in: below investment grade bonds, commercial mortgages, equity, and real estate. LifeCo also has a high percentage of total assets invested in CMO's which exhibit cashflow volatility.
Growth/Profitability:	LifeCo's business mix is shifting to less capital intensive lower margin products.

PERFORMANCE HISTORY

LifeCo was established in 1945; however most of LifeCo's growth has taken place in the last ten years.

Although LifeCo has been profitable on both a Statutory and GAAP basis for the past 6 years, profits have fluctuated. Return on Equity (ROE) has averaged 8% over the past 5 years compared to an ROE of 12% for the industry. LifeCo's stock, on a total return basis, has returned 5%, on average, over the past 3 years.

ENVIRONMENT

In surveys, the company has generally received positive reviews from its customers for service and for value. One weakness of the company has been its public relations department. Early in 1999, LifeCo took steps to deal with this weakness by hiring the one of the top public relations specialists in the country.

The insurance industry in general has received some bad press of late due to perceived market conduct problems. As a result, financial service companies that are not perceived as insurers have taken business away from companies perceived as insurers. LifeCo is definitely viewed as an insurer.

Because of the rapid changes in product design, LifeCo has 16 products running on 6 different administrative systems. With the strong stock market and declining interest rates, money has been moving from the fixed account to the variable accounts for both the variable annuity and the variable life products. The variable life market has been growing recently. The variable annuity market has also been growing, but it has been adversely affected by tax law changes. Additionally, changes in regulation have allowed banks to underwrite variable annuities, and several large banks are offering low load versions of this product. These changes have resulted in a dramatic slowing of variable annuity sales for LifeCo. At the same time, many reinsurers have taken a second look at offering reinsurance for the risk associated with the investment guarantees offered on these products and are now either not willing to provide reinsurance on this business at all or, if they do, at a much higher cost than was previously assumed in pricing.

DESCRIPTION OF ASSETS

General Fund Assets Backing Individual Life & Annuity and Institutional Pensions
LifeCo invests in private placement bonds, public bonds (including CMO's), commercial mortgages, equities and real estate. For private placement bonds, LifeCo tries to maintain a 75% investment grade, 25% below investment grade mix. The current mix is worse than these percentages because of downgrades in the portfolio. 30% of the private placement bonds are callable.

For public bonds LifeCo tries to maintain an 80% investment grade, 20% below investment grade mix. Currently, LifeCo maintains a higher credit quality for the bonds to offset the current mix for the private placement bonds. 75% of the public bonds are callable.

General account assets are segmented into portfolios supporting the liability lines. LifeCo's asset mix backing its pension business is: 83% bonds, 13% commercial mortgages, 2% equities and 2% cash & short term. All bonds and mortgages are denominated in U.S. dollars. LifeCo's asset mix backing its individual life and annuity business, including the liability arising from the guaranteed minimum death benefit, is: 74% bonds, 10% commercial mortgages, 5% equities, 7% real estate, 2% policy loans and 2% cash & short term. LifeCo's asset mix backing its Group Life and Health business is: 85% bonds, 8% commercial mortgages, 5% equities and real estate, and 2% cash and other.

Separate Accounts Variable Annuities and Variable UL Policies

The overall distribution is 70% US equity, 15% US bonds, 5% money market, and 10% international bonds/equity for the variable annuity block. Assets total $2.4 billion for variable annuities, and $1.1 billion for variable universal life.

Correlation Matrix

Fund Type	Volatility	Equity	Bond	Mortgage	Asian	Global	Money Market	Balanced
Equity	18%	1	0.00%	0.00%	25.00%	70.00%	0.00%	95.00%
Bond	4%	0.00%	1	80.00%	0.00%	0.00%	0.00%	0.00%
Mortgage	3%	0.00%	80.00%	1	0.00%	0.00%	0.00%	0.00%
Asian	21%	25.00%	0.00%	0.00%	1	45.00%	0.00%	25.00%
Global	19%	70.00%	0.00%	0.00%	45.00%	1	0.00%	70.00%
Money Market	0%	0.00%	0.00%	0.00%	0.00%	0.00%	1	0.00%
Balanced	9%	95.00%	0.00%	0.00%	25.00%	70.00%	0.00%	1

The derivatives contracts used to hedge the delta exposure are held in the General Fund.

Separate Account Institutional GIC

In total this line of business holds $1.2 billion in market value of assets. Each commingled account offers a different target asset allocation.

Account 1

Treasuries	5%
AA/AAA public corporates	35%
A public corporates	15%
BBB public corporates	10%

	Unit Value	Variable Annuities ($ millions)			Variable UL ($'millions)
		Fund Value	Delta	Gamma	
Equity	18.2	1,042	(189,993)	5,287	258
Bond	13.1	294	(98,102)	4,263	460
Mortgage	11.1	37	(6,467)	66	0
Asian	9.5	49	(10,105)	130	0
Global Equity	14.8	343	(11,559)	6,992	56
Money Market	10	123	(470,985)	896	90
Balanced	15.2	564	(505,539)	30,797	258
Total		2,452			1,122

Note: The Delta and Gamma applies to the minimum guaranteed death benefit included in the variable annuity product.

($ millions:)	Reported Book Value	DAC	Net Book Value	PV of Cash-Flows
Variable Annuities	2459	(74)	2,385	2,360
Variable UL	1122	(28)	1,094	1,085

Govt/Agency MBS passthroughs	25%
High grade private corporate debt	10%

Account 2

Treasuries	5%
AA/AAA public corporates	10%
A public corporates	15%
BBB public corporates	15%
High yield public corporates	15%
Convertible securities	10%
Govt/Agency MBS passthroughs	15%
High grade private corporate debt	10%
Other private debt	5%

Group Long-Term Disability

The asset portfolio is designed to have relatively low liquidity and high total return, with a duration target of 7 years. The target asset allocation is as follows:

Treasuries	5%
Inv Grade public corporates	35%
Govt/Agency MBS passthroughs	20%
High yield public corporates	10%
Commercial mortgages	10%
High grade private corporate debt	10%
Other private debt	5%
Real estate partnerships	5%

Other A&H

Invested assets are managed for high liquidity and high total return

Treasuries	10%
Inv Grade public corporates	50%
Federal/Agency MBS passthroughs	25%
High yield public corporates	10%
Public equities	5%

Total Company (excluding Separate Accounts)

	Assets	Reported Book Value	Book Yield	PV Cash Flows	Effective Duration	Req Capital
	Bonds (total)					
A1a	Gov't	202.4	5.97%	202.8	6.1	1.01
A1b	Public Corporate (Inv. Grade)	1,573.7	6.76%	1,621.0	6.5	23.60
A1c	Public Corporate (below Inv Grade)	399.8	7.21%	419.0	4.5	19.99
A1d	Private Corporate (Inv Grade)	790.3	6.99%	829.1	6.0	15.81
A1e	Private Corporate (below Inv Grade)	437.7	7.54%	470.1	4.6	30.64
A1f	Pass-throughs	274.2	6.88%	288.0	4.4	8.23
A1g	CMO's	219.2	6.60%	227.5	3.6	6.58
A1	*Bonds Subtotal*	*3,897.2*	*6.90%*	*4,057.5*	*5.6*	*105.85*
A2	Cash & short term	103.0	4.75%	103.0	0.1	0.31
A3	Commercial Mortgages	554.0	8.39%	595.0	5.4	27.70
A4	Derivative securities	0.0	0.00%	0.0	-	0.00
A5	Equities	249.3	1.66%	249.3	5.6	49.85
A6	Real Estate (unleveraged)	237.0	9.70%	274.1	5.0	35.56
	Invested Assets Subtotal	*5,040.5*	*6.89%*	*5,278.8*	*5.4*	*219.27*
A7	Accrued investment income	50.3	0.00%	50.3	-	0.00
A8	Policyholder Loans	52.5	7.17%	52.5	0.1	0.00
A9	Provision for asset default	0.0	0.00%	0.0	-	0.00
A10	Other	75.5	0.00%	75.5	-	0.00
A11	***Total Assets***	***5,218.8***	***6.73%***	***5,457.1***	***5.3***	***219.27***

	Liabilities	Reported Book Value	Req Interest	PV Cash Flows	Effective Duration	Req Capital
B1	Benefit liabilities	5,030.8	6.27%	5,220.0	5.3	155.50
B	***Total Liabilities***	***5,030.8***	***6.27%***	***5,220.0***	***5.3***	***155.50***
C	**PreTax Equity**	***188.0***		***237.1***	***5.2***	
	Tax and Other Adjustments					
D1	Future tax payments	65.8		83.0		
D2	Other adjustments					
D	***Subtotal, tax and other adjustments***	***65.8***		***83.0***		
	Net Value (C-D)	**122.2**		**154.1**		

Surplus Account

	Assets	Reported Book Value	Book Yield	PV Cash Flows	Effective Duration	Req Capital
	Bonds (total)					
A1a	Gov't	0 0				0.00
A1b	Public Corporate (Inv. Grade)	9.2	7.53%	4.3	2.2	0 14
A1c	Public Corporate (below Inv Grade)	4.9	9.17%	8.8	3.9	0.25
A1d	Private Corporate (Inv Grade)	3.5	8.01%	5.9	3.8	0.07
A1e	Private Corporate (below Inv Grade)	10 8	9.82%	18.4	5.3	0.76
A1f	Pass-throughs	0.0				0.00
A1g	CMO's	0.0				0.00
A1	*Bonds Subtotal*	*28.4*	*8.74%*	*37.4*	*4.4*	*1.21*
A2	Cash & short term	0 0				0.00
A3	Commercial Mortgages	0.0				0.00
A4	Derivative securities	0 0				0.00
A5	Equities	101.5	2.61%	101.5	4 0	20.30
A6	Real Estate (unleveraged)	58.0	7.23%	95.1	6.0	8.71
	Invested Assets Subtotal	*188.0*	*4.96%*	*234.0*	*4.9*	*30.22*
A7	Accrued investment income	0 0				0.00
A8	Policyholder Loans	0.0				0.00
A9	Provision for asset default	0.0				0.00
A10	Other	0.0				0.00
A11	***Total Assets***	***188.0***	***4.96%***	***234.0***	***4.9***	***30.22***

	Liabilities	Reported Book Value	Req Interest	PV Cash Flows	Effective Duration	Req Capital
B1	Benefit liabilities	0 0				
B	***Total Liabilities***	***0.0***	***0.00%***	***0.0***	***0.0***	***0.00***
C	**PreTax Equity**	***188.0***		***234.0***	***4.9***	
	Tax and Other Adjustments					
D1	Future tax payments	0.0		0 0		
D2	Other adjustments					
D	***Subtotal, tax and other adjustments***	***0.0***		***0.0***		
	Net Value (C-D)	**188.0**		**234.0**		

Individual Life & Annuity - Traditional Life

	Assets	Reported Book Value	Book Yield	PV Cash Flows	Effective Duration	Req Capital
	Bonds (total)					
A1a	Gov't	6.5	6.10%	6.5	13.9	0.03
A1b	Public Corporate (Inv Grade)	51.6	6.90%	54.4	15.0	0.77
A1c	Public Corporate (below Inv Grade)	12.9	7.30%	13.6	7.0	0.65
A1d	Private Corporate (Inv Grade)	28.4	7.00%	29.9	12.0	0.57
A1e	Private Corporate (below Inv Grade)	15.5	7.50%	16.3	5.0	1.08
A1f	Pass-throughs	7.1	7.00%	7.4	4.0	0.21
A1g	CMO's	7.1	7.10%	7.5	4.5	0.21
A1	*Bonds Subtotal*	*129.0*	*7.01%*	*135.7*	*11.1*	*3.53*
A2	Cash & short term	6.0	4.75%	6.0	0.1	0.02
A3	Commercial Mortgages	39.0	8.00%	41.9	5.0	1.95
A4	Derivative securities	0.0	0.00%	0.0	-	0.00
A5	Equities	75.0	1.00%	75.0	7.0	15.00
A6	Real Estate (unleveraged)	21.0	10.50%	21.0	5.0	3.15
	Invested Assets Subtotal	*270.0*	*5.71%*	*279.7*	*8.4*	*23.65*
A7	Accrued investment income	3.0	0.00%	3.0	-	0.00
A8	Policyholder Loans	22.5	7.00%	22.5	0.1	0.00
A9	Provision for asset default	0.0	0.00%	0.0	-	0.00
A10	Other	4.5	0.00%	4.5	-	0.00
A11	***Total Assets***	***300.0***	***5.66%***	***309.7***	***7.6***	***23.65***

	Liabilities	Reported Book Value	Req Interest	PV Cash Flows	Effective Duration	Req Capital
B1	Benefit liabilities	300.0	6.10%	318.0	13.0	2.00
B	***Total Liabilities***	***300.0***	***6.10%***	***318.0***	***13.0***	***2.00***
C	**PreTax Equity**	***0.0***		***-8.3***	***214.2***	
	Tax and Other Adjustments					
D1	Future tax payments	0.0		-2.9		
D2	Other adjustments					
D	***Subtotal, tax and other adjustments***	***0.0***		***-2.9***		
	Net Value (C-D)	**0.0**		**-5.4**		

Individual Life & Annuity - Non-Traditional Life

	Assets	Reported Book Value	Book Yield	PV Cash Flows	Effective Duration	Req Capital
	Bonds (total)					
A1a	Gov't	13.8	6.20%	13.8	12.8	0.07
A1b	Public Corporate (Inv. Grade)	110.0	7.00%	115.0	15.5	1.65
A1c	Public Corporate (below Inv Grade)	27.5	7.50%	29.0	7.5	1.38
A1d	Private Corporate (Inv Grade)	60.5	7.10%	63.8	12.5	1.21
A1e	Private Corporate (below Inv Grade)	33.0	7.60%	34.8	5.2	2.31
A1f	Pass-throughs	15.1	7.00%	15.9	4.0	0.45
A1g	CMO's	15.1	7.30%	16.0	4.5	0.45
A1	*Bonds Subtotal*	*275.0*	*7.12%*	*288.3*	*11.4*	*7.52*
A2	Cash & short term	8.0	4.75%	8.0	0.1	0.02
A3	Commercial Mortgages	44.0	8.00%	47.3	5.0	2.20
A4	Derivative securities	0.0	0.00%	0.0	-	0.00
A5	Equities	5.0	1.00%	5.0	7.0	1.00
A6	Real Estate (unleveraged)	28.0	10.50%	28.0	5.0	4.20
	Invested Assets Subtotal	*360.0*	*7.35%*	*376.6*	*9.8*	*14.95*
A7	Accrued investment income	4.0	0.00%	4.0	-	0.00
A8	Policyholder Loans	30.0	7.30%	30.0	0.1	0.00
A9	Provision for asset default	0.0	0.00%	0.0	-	0.00
A10	Other	6.0	0.00%	6.0	-	0.00
A11	***Total Assets***	***400.0***	***7.17%***	***416.6***	***8.9***	***14.95***

	Liabilities	Reported Book Value	Req Interest	PV Cash Flows	Effective Duration	Req Capital
B1	Benefit liabilities	400.0	6.30%	406.0	4.0	4.00
B	***Total Liabilities***	***400.0***	***6.30%***	***406.0***	***4.0***	***4.00***
C	**PreTax Equity**	***0.0***		***10.6***	***196.9***	
	Tax and Other Adjustments					
D1	Future tax payments	0.0		3.7		
D2	Other adjustments					
D	***Subtotal, tax and other adjustments***	***0.0***		***3.7***		
	Net Value (C-D)	**0.0**		**6.9**		

Individual Life & Annuity - Accumulation Annuity

	Assets	Reported Book Value	Book Yield	PV Cash Flows	Effective Duration	Req Capital
	Bonds (total)					
A1a	Gov't	58.7	6.20%	58.7	5.0	0.29
A1b	Public Corporate (Inv. Grade)	469.5	7.00%	481.2	4.9	7.04
A1c	Public Corporate (below Inv Grade)	117.4	7.50%	120.9	4.5	5.87
A1d	Private Corporate (Inv Grade)	258.2	7.10%	267.3	5.3	5.16
A1e	Private Corporate (below Inv Grade)	140.9	7.60%	148.6	4.3	9.86
A1f	Pass-throughs	64.6	7.00%	67.1	4.6	1.94
A1g	CMO's	64.6	7.10%	67.5	5.2	1.94
A1	*Bonds Subtotal*	*1,173.8*	*7.11%*	*1,211.3*	*4.9*	*32.10*
A2	Cash & short term	30.0	4.75%	30.0	0.1	0.09
A3	Commercial Mortgages	135.0	8.00%	143.1	4.3	6.75
A4	Derivative securities	0.0	0.00%	0.0	-	0.00
A5	Equities	18.8	1.00%	18.8	5.0	3.75
A6	Real Estate (unleveraged)	105.0	10.50%	105.0	4.0	15.75
	Invested Assets Subtotal	*1,462.5*	*7.31%*	*1,508.1*	*4.7*	*58.44*
A7	Accrued investment income	15.0	0.00%	15.0	-	0.00
A8	Policyholder Loans	0.0	0.00%	0.0	-	0.00
A9	Provision for asset default	0.0	0.00%	0.0	-	0.00
A10	Other	22.5	0.00%	22.5	-	0.00
A11	***Total Assets***	***1,500.0***	***7.13%***	***1,545.6***	***4.6***	***58.44***

	Liabilities	Reported Book Value	Req Interest	PV Cash Flows	Effective Duration	Req Capital
B1	Benefit liabilities	1,500.0	5.90%	1,575.0	4.7	15.00
B	***Total Liabilities***	***1,500.0***	***5.90%***	***1,575.0***	***4.7***	***15.00***
C	**PreTax Equity**	***0.0***		***-29.4***	***12.3***	
	Tax and Other Adjustments					
D1	Future tax payments	0.0		-10.3		
D2	Other adjustments					
D	***Subtotal, tax and other adjustments***	***0.0***		***-10.3***		
	Net Value (C-D)	**0.0**		**-19.1**		

Institutional Pensions - Payout Annuity

	Assets	Reported Book Value	Book Yield	PV Cash Flows	Effective Duration	Req Capital
	Bonds (total)					
A1a	Gov't	16.9	6.40%	17.3	10.4	0.08
A1b	Public Corporate (Inv. Grade)	135.4	7.20%	144.2	7.0	2.03
A1c	Public Corporate (below Inv Grade)	33.9	7.60%	36.6	6.5	1.69
A1d	Private Corporate (Inv Grade)	74.5	7.40%	80.1	6.7	1.49
A1e	Private Corporate (below Inv Grade)	40.6	7.90%	44.3	6.0	2.84
A1f	Pass-throughs	18.6	7.10%	19.5	4.0	0.56
A1g	CMO's	18.6	7.30%	19.8	5.0	0.56
A1	*Bonds Subtotal*	*338.5*	*7.33%*	*361.7*	*6.7*	*9.26*
A2	Cash & short term	14.0	4.75%	14.0	0.1	0.04
A3	Commercial Mortgages	286.0	8.75%	308.9	6.0	14.30
A4	Derivative securities	0.0	0.00%	0.0	-	0.00
A5	Equities	44.0	1.00%	44.0	7.0	8.80
A6	Real Estate (unleveraged)	0.0	10.50%	0.0	5.0	0.00
	Invested Assets Subtotal	*682.5*	*7.46%*	*728.6*	*6.3*	*32.40*
A7	Accrued investment income	7.0	0.00%	7.0	-	0.00
A8	Policyholder Loans	0.0	7.00%	0.0	0.1	0.00
A9	Provision for asset default	0.0	0.00%	0.0	-	0.00
A10	Other	10.5	0.00%	10.5	-	0.00
A11	***Total Assets***	***700.0***	***7.28%***	***746.1***	***6.1***	***32.40***

	Liabilities	Reported Book Value	Req Interest	PV Cash Flows	Effective Duration	Req Capital
B1	Benefit liabilities	700.0	6.75%	759.5	7.3	2.00
B	***Total Liabilities***	***700.0***	***6.75%***	***759.5***	***7.3***	***2.00***
C	**PreTax Equity**	***0.0***		***-13.4***	***72.9***	
	Tax and Other Adjustments					
D1	Future tax payments	0.0		-4.7		
D2	Other adjustments					
D	***Subtotal, tax and other adjustments***	***0.0***		***-4.7***		
	Net Value (C-D)	**0.0**		**-8.7**		

Institutional Pensions - GIC

	Assets	Reported Book Value	Book Yield	PV Cash Flows	Effective Duration	Req Capital
	Bonds (total)					
A1a	Gov't	71.6	5.60%	71.6	2.5	0.36
A1b	Public Corporate (Inv. Grade)	573.0	6.40%	584.5	2.8	8.60
A1c	Public Corporate (below Inv Grade)	143.3	6.75%	146.8	3.0	7.16
A1d	Private Corporate (Inv Grade)	315.2	6.80%	329.3	4.3	6.30
A1e	Private Corporate (below Inv Grade)	171.9	7.30%	181.4	4.0	12.03
A1f	Pass-throughs	78.8	6.80%	83.5	5.0	2.36
A1g	CMO's	78.8	5.80%	79.6	1.3	2.36
A1	*Bonds Subtotal*	*1,432.5*	*6.58%*	*1,476.7*	*3.3*	*39.18*
A2	Cash & short term	30.0	4.75%	30.0	0.1	0.09
A3	Commercial Mortgages	0.0	8.00%	0.0	5.0	0.00
A4	Derivative securities	0.0	0.00%	0.0	-	0.00
A5	Equities	0.0	1.00%	0.0	7.0	0.00
A6	Real Estate (unleveraged)	0.0	10.50%	0.0	5.0	0.00
	Invested Assets Subtotal	*1,462.5*	*6.54%*	*1,506.7*	*3.3*	*39.27*
A7	Accrued investment income	15.0	0.00%	15.0	-	0.00
A8	Policyholder Loans	0.0	7.00%	0.0	0.1	0.00
A9	Provision for asset default	0.0	0.00%	0.0	-	0.00
A10	Other	22.5	0.00%	22.5	-	0.00
A11	***Total Assets***	***1,500.0***	***6.38%***	***1,544.2***	***3.2***	***39.27***

	Liabilities	Reported Book Value	Req Interest	PV Cash Flows	Effective Duration	Req Capital
B1	Benefit liabilities	1,500.0	6.60%	1,537.5	3.1	7.50
B	***Total Liabilities***	***1,500.0***	***6.60%***	***1,537.5***	***3.1***	***7.50***
C	**PreTax Equity**	***0.0***		***6.7***	***23.2***	
	Tax and Other Adjustments					
D1	Future tax payments	0.0		2.3		
D2	Other adjustments					
D	***Subtotal, tax and other adjustments***	***0.0***		***2.3***		
	Net Value (C-D)	**0.0**		**4.4**		

Group Benefits

	Assets	Reported Book Value	Book Yield	PV Cash Flows	Effective Duration	Req Capital
	Bonds (total)					
A1a	Gov't	35.0	6.00%	35.0	8.9	0.18
A1b	Public Corporate (Inv Grade)	225.0	6.70%	237.4	12.0	3.38
A1c	Public Corporate (below Inv Grade)	60.0	7.20%	63.3	5.0	3.00
A1d	Private Corporate (Inv Grade)	50.0	6.80%	52.8	8.0	1.00
A1e	Private Corporate (below Inv Grade)	25.0	7.30%	26.4	6.0	1.75
A1f	Pass-throughs	90.0	6.80%	94.5	3.9	2.70
A1g	CMO's	35.0	6.70%	37.1	4.5	1.05
A1	*Bonds Subtotal*	*520.0*	*6.77%*	*546.4*	*8.4*	*13.05*
A2	Cash & short term	15.0	4.75%	15.0	0.1	0.05
A3	Commercial Mortgages	50.0	8.00%	53.8	5.0	2.50
A4	Derivative securities	0.0	0.00%	0.0	-	0.00
A5	Equities	5.0	1.00%	5.0	7.0	1.00
A6	Real Estate (unleveraged)	25.0	10.50%	25.0	5.0	3.75
	Invested Assets Subtotal	*615.0*	*6.92%*	*645.2*	*7.8*	*20.35*
A7	Accrued investment income	6.3	0.00%	6.3	-	0.00
A8	Policyholder Loans	0.0	0.00%	0.0	0.1	0.00
A9	Provision for asset default	0.0	0.00%	0.0	-	0.00
A10	Other	9.5	0.00%	9.5	-	0.00
A11	***Total Assets***	***630.8***	***6.75%***	***660.9***	***7.6***	***20.35***

	Liabilities	Reported Book Value	Req Interest	PV Cash Flows	Effective Duration	Req Capital
B1	Benefit liabilities	630.8	5.90%	624.0	6.5	125.00
B	***Total Liabilities***	***630.8***	***5.90%***	***624.0***	***6.5***	***125.00***
C	**PreTax Equity**	***0.0***		***36.9***	***26.2***	
	Tax and Other Adjustments					
D1	Future tax payments	0.0		12.9		
D2	Other adjustments					
D	***Subtotal, tax and other adjustments***	***0.0***		***12.9***		
	Net Value (C-D)	**0.0**		**24.0**		

APPENDIX B

ASSET LIABILITY MANAGEMENT
POLICY STATEMENT

I. Overall Objective for the ALM Function

ALM is the ongoing process of formulating, implementing and monitoring strategies in respect of assets and liabilities to attain our financial objectives for a given set of risk tolerances and constraints.

As with all financial services companies, risk is an inherent part of doing business. Over the normal course of business LifeCo is exposed to credit risk, interest rate risk, foreign exchange rate risk, off-balance sheet risk, pricing risk, liquidity risk, as well as other various market risks. ALM is a vital ongoing process that requires the management of all these risks.

The principal risk management objectives are to eliminate excessive and unacceptable risk and optimize the risk/return profile of the total company. A key focus of the ALM function at LifeCo is **interest rate risk**.

As a result of timing differences in the repricing of assets and liabilities, fluctuations in market interest rates can affect both accounting earnings and the market value of assets, liabilities and off-balance sheet items and hence the economic value and net worth of LifeCo. The objectives in managing interest rate risk are to:

- Maximize the value of LifeCo's stock subject to stated risk tolerances and constraints (see ALM Guidelines).
- Support the achievement of business strategies while protecting earnings and liquidity.
- Minimize the potential for significant loss as a result of changes in interest rates.
- Manage interest rate risk of current and future earnings to a level that is consistent with the mix of businesses and that limits such exposure to a percentage of the book value of assets.

A key focus of the ALM function at LifeCo is **market risk**. Market risk arises whenever financial results can be adversely affected by changes in the equity markets. The most extreme exposure to market risk occurs when investment guarantees are offered. The risk exposure associated with these guarantees is managed by using a dynamic delta hedging strategy.

Liquidity risk is the risk that LifeCo will be unable to maintain cash flows that are adequate to fund its operations and meet all present and future financial obligations on a timely and cost effective basis

A separate Liquidity Policy details the management of LifeCo's liquidity risk.

Foreign exchange rate risk arises whenever future payments in a foreign currency are made or received. A loss occurs if there is an appreciation (in the case of foreign dollars owed) or depreciation (in the case of foreign dollars due) of the local currency relative to the foreign currency. The objective is to eliminate any foreign exchange rate risk. This is accomplished through the use of currency swaps.

Credit risk includes the risk of default on scheduled payments of either interest or principal. Credit quality guidelines are determined by the Investment Department of LifeCo, approved by the Board of Directors and are specified in the Investment Policy. The credit quality of the assets is monitored by the Investment Department of LifeCo and reported to the Board of Directors.

Off-balance sheet risk refers to the risk associated with derivative instruments. The Operational Guidelines for Use of Derivatives provides control procedures and details the management of LifeCo's exposure to derivatives risk.

II. ALM Process

The ALM process consists of four fundamental steps:

Identify the level of risk exposure
It is a requirement that at all times the exposure to all risks be quantified. This is accomplished by regular measurement and monitoring of the exposure to various risks.

Decide whether the risk exposure is appropriate
The purpose of ALM is not necessarily to eliminate or even minimize risk. The level of risk will vary with the return requirement and financial objectives. Return objectives and risk tolerances are determined by LifeCo and reviewed from time to time.

Modify the existing risk
This is accomplished by rebalancing the portfolio or through the use of interest rate swaps, currency swaps or other hedging techniques to offset risk.

Optimize the risk/return profile of the business
For a given level of risk financial objectives are maximized. Optimization ensures that portfolios lie on the risk/return efficient frontier for LifeCo's stated return objectives, risk tolerances and constraints.

III. ALM Committee Purpose

Risk tolerances are determined by the ALM Committee and approved by the Board of Directors. Asset/Liability strategies as well as the policies and guidelines for the management of the aforementioned risks are established by the ALM committee. The ALM committee discusses limits on potential earnings fluctuations that could arise from interest rate risk as well as on- and off- balance sheet accrual positions. The ALM committee monitors exposures in view of market developments and LifeCo's financial condition, provides guidance for interest rate risk management decisions and monitors

liquidity and capital adequacy. ALM policy is established by the ALM Committee, reviewed by the Board of Directors at least annually and is implemented by the Investment Department in conjunction with the Corporate Actuarial Department and the Finance division.

IV. ALM Committee Composition/Frequency of Meetings

The ALM committee meets monthly and consists of the CEO, CFO, Chief Actuary, CIO, VP Risk Management and includes representation from functional areas as appropriate. Committee proceedings are chaired and recorded by the VP Risk Management.

V. ALM Guidelines

LifeCo's exposure to interest rate risk is quantified by calculating price sensitivity statistics such as effective duration, dollar duration, convexity, partial durations, delta, and by performing scenario testing and cash-flow analysis. A pure dedication strategy of matching asset and liability cash-flows is widely recognized as costly, unnecessary and would not be appropriate for LifeCo. Negative net cash flows are identified and assessed from a liquidity perspective only. Exposure to interest rate risk is monitored for each product line and for all major products. Although ALM is performed at both the product and product line level, specific guidelines are set for Accumulation Annuities in total, Traditional Life Products in total, Non-Traditional Life Products in total and total company surplus.

(a) Accumulation Annuities

Dollar Duration of Assets less Dollar Duration of Liabilities	< 30% x book value of assets
Partial Duration Sensitivity	< 0.02% x book value of assets for any and all partial durations
Worst Case Scenario at 95% Confidence Level	< 0.50% x book value of assets

(b) Variable Annuities

Delta of liability less delta of assets	<10% of delta of liability
Gamma	Unhedged
Vega	Unhedged
Rho	<5% of rho of liability
(Rho of liability less rho of assets)	

(c) Traditional Life Products

Dollar Duration of Assets less Dollar Duration of Liabilities	< 100% x book value of assets
Partial Duration Sensitivity	< 0.10% x book value of assets for any and all partial durations
Worst Case Scenario at 95% Confidence Level	< 5.00% x book value of assets

(d) Non-Traditional Life Products

Dollar Duration of Assets less Dollar Duration of Liabilities	< 100% x book value of assets
Partial Duration Sensitivity	< 0.10% x book value of assets for any and all partial durations
Worst Case Scenario at 95% Confidence Level	< 5.00% x book value of assets

(e) Institutional Pension - Payout

Dollar Duration of Assets less Dollar Duration of Liabilities	< 100% x book value of assets
Partial Duration Sensitivity	< 0.10% x book value of assets for any and all partial durations
Worst Case Scenario at 95% Confidence Level	< 5.00% x book value of assets

(f) Institutional Pension - GIC

Dollar Duration of Assets less Dollar Duration of Liabilities	< 30% x book value of assets
Partial Duration Sensitivity	< 0.02% x book value of assets for any and all partial durations
Worst Case Scenario at 95% Confidence Level	< 2.00% x book value of assets

(g) Group Business

Dollar Duration of Assets less	< 100% x book value of assets

Dollar Duration of Liabilities	
Partial Duration Sensitivity	< 0.1% x book value of assets for any and all partial durations
Worst Case Scenario at 95% Confidence Level	< 5.00% x book value of assets

(h) Total Company

Dollar Duration of Assets less Dollar Duration of Liabilities	< 100% x book value of assets
Partial Duration Sensitivity	< 0.05% x book value of assets for any and all partial durations
Worst Case Scenario at 95% Confidence Level	< 2.00% x book value of assets

(i) Surplus

Dollar Duration of Actual Assets less Dollar Duration of Benchmark	< 100% x book value of assets

Where the effective duration of the benchmark is assumed to be 10 years and the present value of the benchmark is assumed equal to the present value of the assets.

In order to ensure that the above guidelines are met for each product line, it may be necessary to rebalance the portfolio by trading assets or through the use of financial engineering. Rebalancing is performed periodically for Accumulation Annuities and for Life Products. In addition to meeting the above guidelines, for rebalancing purposes, each asset segment should have assets that do not exceed the liabilities by more than +/- $2,000,000.

The Investment Department has discretion to position the portfolio within the above guidelines.

I. Reporting

Corporate Actuarial reports on LifeCo's ALM position to the Investment Department and the ALM Committee on a quarterly basis. For Accumulation Annuities the ALM position is monitored on a weekly basis and reflects all asset commitments from the time at which they are priced. Corporate Actuarial reports on LifeCo's ALM position to the Board of Directors at each of its meetings.

The quarterly reports include a discussion of exposure to interest rate risk, changes in market interest rates during the period, the results of scenario testing and various technical notes. Attached to the report are the following:

- price sensitivity statistics including effective duration, dollar duration, convexity, and partial duration sensitivity analysis
- cash flow analysis
- a comparison of the mismatch provision for the past 12 months
- book values and market values of assets and liabilities
- a comparison of the term structure of interest rates for the current and prior periods

Appendix D contains a sample ALM report.

II. Allocation of Asset Commitments

Status of Commitments

Portfolio management prepares a weekly report on the status of asset commitments which contains information on the following stages of commitment:

1. Under Review/Negotiation
2. Under Application/Recommended for Investment
3. Internal Approval - Not Yet Committed
4. Committed - Not Yet Priced
5. Priced
6. Funded

Allocation of Commitment to Product Lines

Once an asset reaches the committed stage, Portfolio Management reviews each of the product line portfolios in terms of the liability characteristics and ALM guidelines and allocates the commitment to the most suitable product line. Once an asset reaches the committed stage the Investment Department will determine whether a hedge transaction will be needed between the time the commitment is priced and the time it is funded.

Determination of Method of Funding

The committed asset is added to the portfolio for purposes of measuring exposure to interest rate risk. Portfolio management examines the impact of various funding alternatives and recommends the purchase of asset(s) that optimizes the portfolio with respect to LifeCo's financial objectives within the approved ALM guidelines.

Priced Commitments
Committed assets are not reflected for ALM purposes until they become priced. Until this point there is no exposure to interest rate risk. If a hedge transaction was previously deemed necessary, it will be affected once the asset becomes priced.

III. Hedging

Measurement
A hedge is the assumption of an additional risk exposure that offsets an existing risk. The intended effect of a hedge is to reduce the overall portfolio risk (e.g. currency or interest rate risk). Thus the impact on the overall risk exposure of the portfolio is examined for all hedges. Although hedges are examined at the portfolio level, care must be taken to ensure that any derivatives transactions are appropriately arranged to qualify for hedge accounting treatment where intended.

IV. Priced Commitments
A newly priced commitment will add exposure to interest rate risk to a portfolio. Before a hedge is affected for this transaction the overall impact on the portfolio must be examined.

V. Portfolio Rebalancing
From time to time, portfolio rebalancing will be required to keep the assets in balance with the liabilities and in accordance with ALM guidelines specified in the ALM Policy Statement. Formally, all portfolios are reviewed quarterly with the exception of the Accumulation Annuities portfolio that is reviewed monthly. Optimization is also performed in order to maximize LifeCo's expected returns subject to its risk tolerances and constraints. Portfolio rebalancing and optimization may involve asset trades and/or the use of financial engineering. Any asset transfer between asset segments must be done at market value and requires the physical sale and purchase of assets. Transfers at book value are strictly prohibited.

VI. Interest Rate Sensitivity
A number of tools are used to measure the interest rate sensitivity of the assets and liabilities.

Effective duration provides a measure of the interest rate sensitivity in percentage terms of the market value of the assets and liabilities for a parallel change in interest rates. For example, if the effective duration of an asset is 4, then for a 100 basis point increase in interest rates the market value of the asset will decline by approximately 4%. Effective duration will explicitly recognize interest sensitive cash flows whenever a suitable model is available, otherwise expected cash flows will be used.

Dollar duration provides a measure of the interest rate sensitivity in dollar terms of the market value of the assets and liabilities for a parallel change in interest rates. For

example, if the dollar duration of assets is $100 million greater than the dollar duration of liabilities, then for a 100 basis point increase in interest rates for all terms to maturity across the yield curve, the market value of assets will decrease by approximately $1 million more than the market value of liabilities. The measurement of dollar duration is consistent with effective duration.

Convexity measures the rate of change of effective duration. Effective duration only provides an approximation of the price sensitivity to changes in interest rates. The precision of the approximation deteriorates as the change in interest rates increases. Including convexity improves the approximation. In general, assets with greater convexity are more desirable than assets with less convexity. This is because as interest rates decrease the increase in the market value of the assets increases at a faster rate. Conversely, as interest rates increase the rate of decrease in the market value of the assets decreases. It is therefore desirable to have assets, which have higher convexity than the liabilities.

Partial durations provide measures of the interest rate sensitivity in percentage terms of the market value of the assets and liabilities for a change in each portion of the yield curve. The sum of partial durations is equal to the effective duration described above.

Partial duration sensitivity measures the impact on market value of changes in interest rates at various terms to maturity along the yield curve. It is a dollar duration type of calculation using partial durations. This is a valuable tool as interest rates seldom move in a parallel fashion.

Cashflow analysis assumes no renewal or reinvestment of cash flows and must be interpreted with care. It is not necessary or advisable to be perfectly cashflow matched; however, large net cash outflows must be considered in the context of liquidity available in the portfolio.

Scenario testing is performed on a deterministic basis and involves measuring the sensitivity of economic value to both parallel and non-parallel yield curve shifts.

Asset Quality

Credit quality guidelines are contained in the Investment Policy and specify maximum holdings of individual credits for new purchases (these maximums decline as credit quality declines). The guidelines also specify an average quality constraint on the total portfolio. It is the philosophy of LifeCo that the credit risk exposure of the Company's assets should be highly diversified, actively managed, and under continuous review by the Investment Department. The ALM committee will be informed by the Investment Department of the credit risk exposure of the Company's assets to monitor compliance with the credit quality guidelines.

VII. Liquidity

Cash flow analysis is performed which provides an indication of the potential liquidity requirements of the portfolio. In addition, asset mix is monitored with respect to renewal and surrender experience to ensure that sufficient liquid assets exist to meet anticipated cash outflow requirements.

VIII. Capital Adequacy

Target capital is 150% of regulatory capital required.

IX. Profitability

Profitability is measured in terms of return on total company surplus. Economic value is the central focus of ALM, with the impact on GAAP income a constraint.

X. Specific Responsibilities

ALM Committee

The ALM Committee is responsible for overall policy formulation as detailed in the Policy Statement. The ALM Committee is also responsible for monitoring the ALM position of LifeCo and reporting whether all guidelines are being adhered to.

ALM Sub-Committees

Portfolio Rebalance Subcommittee

All asset trades affect the statutory reserve and mismatch provision under GAAP, the measurement of profitability, the economic value of surplus, partial duration sensitivity, capital requirements and the return on capital. In addition to determining whether a trade increases the yield to maturity - or even the total rate of return - of a portfolio, the aforementioned considerations need to be taken into account whenever any asset trade is contemplated. The function of this subcommittee is to examine portfolio changes, quantify the impact of derivatives and asset trades, monitor and measure the exposure to interest rate and other risks and perform optimization of all portfolios. This subcommittee meets a minimum of once per quarter and consists of a representative from the Investment Department, Corporate Actuarial and Finance.

Rate Setting Subcommittee

The function of this subcommittee is to determine crediting rates for both Life and Accumulation Annuities. This subcommittee meets weekly and consists of a representative from the Investment Department, Corporate Actuarial, Finance, Marketing Actuarial and Accumulation Annuities Marketing.

Product Managers

The Life and Investment Product vice-presidents are responsible for the execution of business strategies decided at ALM Committee

Corporate Actuarial

Corporate Actuarial is responsible for monitoring ALM policy to see whether ALM guidelines are adhered to. Corporate Actuarial projects asset and liability cash flows, calculates all price sensitivity statistics, performs partial duration sensitivity analysis and scenario testing, and determines reserves and mismatch provisions. Corporate Actuarial assists the Investment Department in the selection of asset trades and the use of financial engineering.

Investment Department

The Investment Department is responsible, with input from Corporate Actuarial, for the determination and execution of all trades, financial engineering and hedging strategies in accordance with the guidelines specified in the ALM Policy Statement. The Investment Department communicates all transactions including forward commitments to Finance and Corporate Actuarial and distributes a quarterly report on the status of mortgage and private placement commitments and related hedging arrangements

Finance

Finance is responsible for recording all transactions and keeping the asset accounting system up to date. Finance provides electronic files of bonds and private placements on a quarterly basis.

APPENDIX C

OPERATIONAL GUIDELINES FOR USE OF DERIVATIVES

I. Overview

LifeCo, by the nature of its business activities and products, is routinely exposed to risks such as those described in sections V through VIII.

LifeCo portfolio managers purchase derivatives to manage the risks that are identified by the liability product managers, Finance, and/or Corporate Actuarial. Derivatives may not be purchased for speculative purposes.

The guiding principle in the use of derivatives is that LifeCo is a limited end-user acting primarily to reduce risk. Strategies that involve the writing of options by LifeCo are specifically excluded, with the exception of options embedded in LifeCo's products or issued company debt.

II. Definition of Derivatives

For purposes of these guidelines, derivatives are defined as contracts that the company enters into with a counterparty, where the contract value derives from the value of an underlying asset or underlying reference rate or index. Such indices include, but are not limited to, LIBOR, U.S. Treasury instruments, and the S&P 500 index. This definition of derivatives includes instruments as described in section IX. This definition does not include asset classes such as mortgage-backed securities, collateralized mortgage obligations, asset-backed securities, and other structured assets that are treated as bonds for statutory accounting and regulatory purposes.

III. Responsibilities

The ALM Committee is responsible for reviewing the type and amount of each derivative purchase. The Investment Department is responsible for the purchase of derivatives. The Finance Department is responsible for derivatives accounting and reporting. The ALM Committee is responsible for all board reports relating to derivatives activity.

IV. Objectives

The primary objective of derivatives use at LifeCo is to reduce potential volatility in the future operating income of the lines of business. Depending on the source of the volatility and the type of derivative purchased, the derivative may reduce both upside and downside earnings volatility, or may reduce only downside earnings volatility.

V. Business Exposures Managed

LifeCo's life insurance and accumulation annuity products have minimum interest guarantees. In an extended period of low interest rates, profit margins would be reduced, and possibly even be negative.

The life insurance and accumulation products allow surrenders at book value, possibly with a book value surrender charge. In periods of rapidly rising interest rates, the assets backing these products would not support a credited rate that is competitive with new money rates. If the company chose to maintain competitive credited rates, then profit margins would be reduced or even be negative. If the company chose to maintain profit margins with an uncompetitive credited rate, then policy surrenders could increase, leading to a loss of future profit margins and market value losses on asset sales to pay the surrender benefits.

LifeCo's equity-linked GIC credits a rate that is linked to the performance of the S&P 500 equity index. This product also guarantees the return of principal. LifeCo's investments need to meet both of these guarantees.

LifeCo's variable annuities contain a GMDB benefit. This benefit exposes the company to equity market risk. In an extended period of low or negative equity market returns, death claims may be greater than the corresponding account values of the variable annuities. This risk is managed through a dynamic delta hedging strategy. The company matches the delta on its variable annuity block to the delta of a book of S&P 500 futures. The futures position is updated weekly for changes in the inforce as well as changes in the market and the fund returns relative to the market. The gamma and vega are unhedged.

VI. Mismatch risk

The company's assets and liabilities are not cash flow matched. In time periods where the company's asset cash flows exceed the liability cash flows, there is reinvestment risk. For example, the assets allocated to the payout annuity business are shorter than the liability cash flows. Since the payout annuity benefits cannot be changed, reinvestment risk would be realized if interest rates were low at the time of the asset reinvestment.

In time periods where the company's liability cash flows exceed the asset cash flows, there is funding risk. For example, if assets have to be sold to pay excess benefits at a time when interest rates are high, market value losses will be realized on the asset sales. There is also potential mismatch risk in LifeCo's equity-linked GIC. If the assets allocated to this business do not match the performance guarantee relative to the S&P 500 index, then the profits may vary substantially from the product's pricing assumption.

VII. Mortgage commitment risk

LifeCo's Investment Department commits to funding commercial mortgage loans weeks in advance of disbursing funds for the loan. These commitments require a loan rate to be locked in at that time for the mortgage. If interest rates rise between this commitment

date and the disbursement date, then the earned rate on these assets acquired on the disbursement date will be lower than the earned rates that the liability pricing areas would expect the Investment Department to be able to achieve in then current interest rate environment.

VIII. Foreign exchange risk

The Investment Department may invest in assets denominated in foreign currencies. In addition, the funding agreement program produces future liability cashflows denominated in more than one currency. As currency exchange rates fluctuate, the value of LifeCo's investment income and operating income will also fluctuate unless the currency risk is hedged.

IX. Approved Derivative Classes

The Board of Directors has currently approved the purchase, subject to the guidelines detailed below, of the types of derivatives listed below. Derivatives not in these categories may be purchased only with the prior approval of both the Chief Investment Officer and Chief Executive Officer of LifeCo.

Interest rate swaps: interest rate swaps are bilateral agreements between LifeCo and a counterparty to exchange a series of cash flows at specified intervals. The cash flows may be fixed or floating. Floating-rate cash flows would be calculated based on a set formula and reference index. Swap terms and conditions such as a reference index, frequency of payments, expiry date of the contract, and notional amount of the contract are set at the time of the swap purchase.

Government bond futures: a futures contract obligates its owner to buy a specified amount of a specified government bond at a specified price on a specified date. These contracts are used by LifeCo in either "long" positions (an agreement to buy a government bond) or "short" positions (an agreement to sell a government bond). Futures contracts are entered into directly with an exchange clearinghouse.

Purchased options on government bond futures: these options give LifeCo the right, but not the obligation, to buy (or sell, depending on the type of option) government bond futures at a set price on a set future date. These options allow LifeCo to benefit from favorable price movements in government bond futures. LifeCo's loss on unfavorable price movements is limited to the premium paid to purchase the option.

Forward rate agreements: these agreements are similar to the futures described above, but they are negotiated with other financial institutions rather than an exchange clearinghouse. They are agreements that a certain interest rate will apply to a certain principal amount for a certain time period in the future.

Foreign currency swaps: these are bilateral agreements between LifeCo and a counterparty whereby interest and principal in one currency are exchanged for interest and principal in another currency.

Foreign currency forward rate agreements: forwards are transacted over-the-counter, typically with a domestic Schedule I bank. LifeCo agrees to buy or sell a specific amount of foreign currency at a specified rate of exchange on a specified date.

Foreign currency futures: LifeCo agrees to buy or sell a specific amount of foreign currency at a specified rate of exchange on a specified date. The actual currency transaction being hedged seldom coincides with the maturity of the futures contract. The futures are usually sold prior to maturity and the gain or loss on the contract is used to offset the increase or decrease in the value of the currency transaction being hedged.

Purchased interest rate caps and floors: interest rate caps protect LifeCo in rising interest rate environments by paying the excess, if any, of a prevailing reference rate at a future date over the strike rate in the contract. The contract has a set notional amount, maturity date, payment dates, and reference rate. Since only positive differences are paid to LifeCo, LifeCo's only outlay is the premium paid for the cap. Interest rate floors are similar to caps, but protect LifeCo in falling rate environments by paying the excess, if any, of the contract's strike rate over the prevailing reference rate at a future date.

Equity index futures: LifeCo agrees to buy or sell the value of the S&P 500 index on a specified maturity date. The futures are usually sold prior to maturity and the gain or loss on the contract is used to offset the increase or decrease in the value of the variable annuity block. Each futures contract is for $250 times the S&P 500 index.

Equity index options: European-type call options on the S&P 500 index give LifeCo a payment at maturity equal to the excess, if any, of the value of the index over the option's strike price. Each call option contract is for $100 times the value of the index. LifeCo's only outlay is the premium paid for the call option.

Credit Default Swaps: These contracts establish an economic value for transferring credit risk between parties in isolation from other risks (such as interest rate, market price, and foreign currency). They allow investors to hedge credit risk by buying credit protection or assume credit risks on individual names or a basket of securities to enhance yield and diversification. The elements of such contracts include: counterparty, notional, reference entity (whose credit risk is transferred) obligation (class of debt instruments whose credit risk is transferred), credit event (event triggering payment), premium fee (payable for the protection), maturity (or tenor) of the swap, and settlement (details of how the protection buyer is paid on the occurrence of a credit event.)

Swaptions: These are options on interest rate swaps, which give LifeCo the right to enter into a certain interest rate swap at a certain time in the future. A receiver (or call) swaption is such a contract in which LifeCo has purchased the right to enter into a receive-fixed rate swap for a specified period at a predetermined option exercise date in the future, while a payer (or put) swaption is a contract in which LifeCo has purchased the right to enter into a pay-fixed rate swap. These instruments may be used as alternatives to purchasing interest rate floors and caps as hedges in falling or rising rate scenarios.

Spread Locks: Spread locks may be used as a hedge against the risk of corporate and swap spreads widening that may result from the flattening of the yield curve. A typical application would be in the case of an investor's concern with the spread exposure resulting from a high allocation to credit-sensitive securities. The contract has a set notional, maturity date, spread lock, and the tenor (or maturity) of the interest rate index whose spread is being measured. The payoff from this instrument is equal to the notional times the duration of the interest index times the spread difference between the actual spread level and the spread lock.

X. Acquisition of Derivatives

Interest rate swaps may be entered into in combination with a floating rate asset to achieve a fixed rate of return. The procedures and policies are then the same as the procedures and policies for acquiring fixed rate assets. If an interest rate swap is used for other ALM purposes, the ALM Committee must submit a written request to the Investment Department.

Purchases of interest rate caps and floors and equity options must be in the form of a written request from the ALM Committee to the Investment Department. The Investment Department must obtain a minimum of two quotes from approved counterparties.

XI. Transaction Approval

Each derivative purchase will result in a written sheet with the terms and conditions (the "confirmation sheet") of that derivative. This sheet must be signed by the Investment Department employee responsible for that purchase.

XII. Exposure Limits

The net market value exposure of all interest rate and currency swaps with any one counterparty will not exceed $250 million. The market value of all equity call options with any one counterparty will not exceed $100 million. The market value of all interest rate caps and floors with any one counterparty will not exceed $100 million.

XIII. Transaction Documentation and Control Procedures

Each derivative purchase results in a confirmation sheet (see section XI). A copy of this sheet is sent by the Investment Department to the Finance Department. The Finance Department maintains a file for all derivatives. The Finance Department documents all payments made and received under swap contracts and verifies the calculation of these payments The Finance Department also verifies the amounts of payments, if any, due from the counterparty on all caps and floors each time a payment, if any, is due. The Vice President of Finance reviews and initials all of these payment calculations.

XIV. Accounting and Disclosure

LifeCo will follow all required accounting practices for derivatives and disclose the balance sheet effect of derivatives in all shareholder reports and other required reports for securities regulators.

XV. Communication of Purchases

The Board of Directors will be notified of each derivative purchase at the next scheduled board meeting following such purchase.

XVI. Approved Counterparties

Counterparties must have a credit rating of at least BBB from Mud & Poor's Agency. LifeCo must have a master ISDA agreement signed with the counterparty prior to the derivative purchase. Each agreement is subject to the approval of LifeCo's Secretary and General Counsel.

XVII. Market Valuation

Each December 31st, the Investment Department will obtain market valuations for each derivative from the counterparty for that derivative. A report showing the market values and market values from the prior December 31st will be provided to the ALM Committee.

XVIII. Administration

All derivatives will be maintained where possible on LifeCo's Investment Administration System. If a derivative cannot be administered on this system, it will be identified in an exception report, which will be submitted by the Finance Department to the ALM Committee each December 31st. This report will show, for each derivative not administered on the Investment Administration System, the type of derivative, the counterparty, the purchase date, the notional amount, and the current market value as provided by the Investment Department.

XIX. Sample Term Sheets

Term Sheet for a Credit Default Swap:

Counterparties:	Party A (Buyer of Credit Protection) Party B (Seller of Credit Protection)
Notional Amount:	$10,000,000
Reference Entity:	Entity / obligor whose credit risk is to be transferred (e.g., IBM, GM, US corporate index)
Obligation:	Class of debt instruments whose credit risk is transferred (e.g., senior unsecured long-term debt obligations)
Credit Event:	Bankruptcy, failure to pay coupon or principal on time, or a Restructuring
Premium Due:	140 basis points
Maturity (or Tenor):	5 Years
Settlement:	Physical delivery or cash settlement

Term Sheet for a Spread Lock

Counterparties:	Party A (Buyer of Spread Protection) Party B (Seller of Spread Protection)
Notional Amount:	$10,000,000
Maturity:	"N" Years
Interest Index:	Index whose spread is being measured (e.g., 5-year Constant Maturity Swap, 10-year Baa corporate index)
Spread Lock:	150 basis points

Term Sheet for a Swaption:

Counterparties:	Party A (Floating Rate Payer) Party B (Fixed Rate Payer)
Type of Swaption:	Receiver or Payer Swaption
Notional Amount:	$10,000,000
Maturity of Swap:	"N" Years
Fixed Rate:	Predetermined fixed rate (or strike rate)
Fixed Rate Payment Frequency:	Semi-annual, 30/360 basis
Floating Rate:	3-month Libor flat
Floating Rate Payment Frequency:	Quarterly, 30/360 basis
Exercise Option Date:	Some future date in the future
Option Cost:	Upfront cost in basis points or Annual cost in basis points
Settlement:	Physical delivery or Cash Settlement

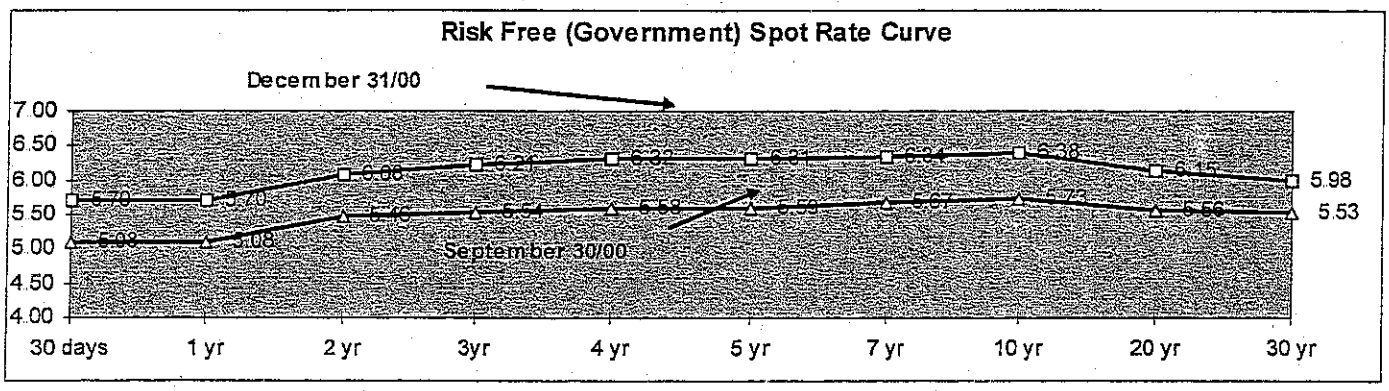
APPENDIX D

Asset Liability Management Report for

December 31, 2000

This report details the ALM position for all of LifeCo's products and focuses on the company's exposure to interest rate risk. The ALM guidelines specified in the company's ALM Policy Statement and Procedure Manual reflect the company's tolerance to interest rate risk.

Interest Rates



Implied Forward Curve

# of Years From Today	Treasury Yields By Maturity						
	1	2	3	5	7	10	30
0.0	5.34	5.08	5.11	4.99	5.05	5.14	5.42
0.5	4.81	4.87	4.94	4.91	5.00	5.13	5.45
1.0	4.81	5.00	4.97	4.96	5.05	5.18	5.53
1.5	4.92	4.99	4.93	4.98	5.07	5.25	5.59
2.0	5.18	5.04	4.92	5.03	5.12	5.28	5.66
2.5	5.05	4.93	4.93	5.05	5.14	5.33	5.71
3.0	4.88	4.79	4.93	5.06	5.16	5.38	5.76
3.5	4.78	4.86	4.98	5.10	5.21	5.44	5.82
4.0	4.67	4.94	5.03	5.14	5.27	5.50	5.87
4.5	4.92	5.06	5.13	5.22	5.35	5.57	5.93
5.0	5.20	5.20	5.24	5.30	5.44	5.64	5.99

Stress Scenario #1 Forward Rates

# of Years	Treasury Yields By Maturity						
From Today	1	2	3	5	7	10	30
0.0	5.34	5.08	5.11	4.99	5.05	5.14	5.42
0.5	4.60	4.77	4.84	4.85	4.95	5.12	5.48
1.0	4.60	4.96	4.89	4.94	5.05	5.22	5.64
1.5	4.75	4.95	4.82	4.97	5.09	5.36	5.76
2.0	5.12	5.02	4.81	5.06	5.19	5.42	5.90
2.5	4.93	4.86	4.82	5.10	5.23	5.52	6.00
3.0	4.70	4.65	4.82	5.12	5.27	5.62	6.10
3.5	4.56	4.75	4.90	5.19	5.37	5.74	6.22
4.0	4.40	4.87	4.98	5.26	5.49	5.86	6.32
4.5	4.75	5.05	5.14	5.40	5.65	6.00	6.44
5.0	5.14	5.26	5.32	5.55	5.83	6.14	6.56

Stress Scenario #2 Forward Rates

# of Years	Treasury Yields By Maturity						
From Today	1	2	3	5	7	10	30
0.0	1.47	2.14	2.72	3.53	4.04	4.52	4.99
0.5	2.09	2.76	3.28	4.01	4.48	4.96	5.46
1.0	2.80	3.39	3.80	4.39	4.78	5.19	5.62
1.5	3.39	3.87	4.21	4.70	5.03	5.38	5.75
2.0	3.94	4.30	4.57	4.96	5.24	5.55	5.86
2.5	4.32	4.62	4.84	5.17	5.42	5.69	5.95
3.0	4.63	4.88	5.06	5.34	5.56	5.81	6.02
3.5	4.89	5.11	5.25	5.50	5.69	5.91	6.09
4.0	5.11	5.29	5.41	5.62	5.78	6.00	6.13
4.5	5.29	5.43	5.36	5.74	5.89	6.07	6.18
5.0	5.44	5.55	5.64	5.83	5.97	6.14	6.21

Stress Scenario #3 Forward Rates

# of Years	Treasury Yields By Maturity						
From Today	1	2	3	5	7	10	30
0.0	1.47	2.14	2.72	3.53	4.04	4.52	4.99
0.5	2.34	3.07	3.62	4.39	4.92	5.40	5.93
1.0	3.33	4.02	4.45	5.08	5.52	5.86	6.25
1.5	4.16	4.74	5.10	5.64	6.02	6.24	6.51
2.0	4.93	5.38	5.68	6.10	6.44	6.58	6.73
2.5	5.46	5.86	6.11	6.48	6.80	6.86	6.91
3.0	5.89	6.25	6.46	6.79	7.08	7.10	7.05
3.5	6.26	6.60	6.77	7.08	7.34	7.30	7.19
4.0	6.57	6.87	7.02	7.29	7.52	7.48	7.27
4.5	6.82	7.08	6.94	7.51	7.74	7.62	7.37
5.0	7.03	7.26	7.39	7.67	7.90	7.76	7.43

Baa Corporate Spreads

# of Years	Nominal Spreads Over Treasuries of Comparable Maturity						
From Today	1	2	3	5	7	10	30
0.0	69	88	99	92	100	109	122
0.5	74	92	103	97	105	113	126
1.0	79	96	106	102	109	117	131
1.5	84	100	110	107	114	122	135
2.0	89	104	113	112	118	126	139
2.5	95	109	117	117	123	130	144
3.0	100	113	121	121	128	134	148
3.5	105	117	124	126	132	138	152
4.0	110	121	128	131	137	143	156
4.5	115	125	131	136	141	147	161
5.0	120	129	135	141	146	151	165

Summary of ALM Position

At December 31, significant mismatches existed in the Life and Group Benefit portfolios, all other portfolios were within the guidelines specified in the ALM Policy Statement and Procedure Manual. Various ways are being investigated to reduce asset liability mismatches. It is anticipated that extensive rebalancing of the affected asset portfolios will be required. A summary of the ALM position for LifeCo follows.

		Book Value ('000)	Present Value ('000)	Effective Duration	Dollar Duration ('000)
TRADITIONAL LIFE PRODUCTS					
Assets		300,000	309,700	7.8	2,424,000
Liabilities		300,000	318,000	13.0	4,134,000
	Difference	0	-8,300	-5.2	-1,710,000
	Guideline	< 2,000			< 300,000
NON-TRADITIONAL LIFE PRODUCTS					
Assets		400,000	416,600	9.3	3,859,000
Liabilities		400,000	406,000	4.0	1,624,000
	Difference	0	10,600	5.3	2,235,000
	Guideline	< 2,000			<400,000
ACCUMULATION ANNUITIES					
Assets		1,500,000	1,545,600	4.7	7,257,000
Liabilities		1,500,000	1,575,000	4.7	7,403,000
	Difference	0	-29,400	0.0	-146,000
	Guideline	< 2,000			<450,000
INSTITUTIONAL PENSION – PAYOUT					
Assets		700,000	746,100	6.5	4,870,000
Liabilities		700,000	759,500	7.3	5,544,000
	Difference	0	-13,400	-0.8	-675,000
	Guideline	< 2,000			< 700,000
INSTITUTIONAL PENSION – GIC					
Assets		1,500,000	1,544,200	3.3	5,067,000
Liabilities		1,500,000	1,537,500	3.1	4,766,000
	Difference	0	6,700	-0.2	300,000
	Guideline	< 2,000			< 450,000
GROUP BENEFITS					
Assets		630,800	660,900	8.0	5,262,000
Liabilities		630,800	624,000	6.5	4,368,000
	Difference	0	36,900	1.5	1,206,000
	Guideline	< 2,000			< 630,000
SURPLUS ACCOUNT					
Assets		188,000	243,020	9.5	2,211,000
Target					
	Difference	188,000	243,020		
	Guideline				
TOTAL COMPANY					
Assets		5,218,800	5,457,100	5.5	30,063,000
Liabilities		5,030,800	5,220,000	5.3	27,527,000
	Difference	188,000	237,100		2,535,000
	Guideline				< 5,219,000

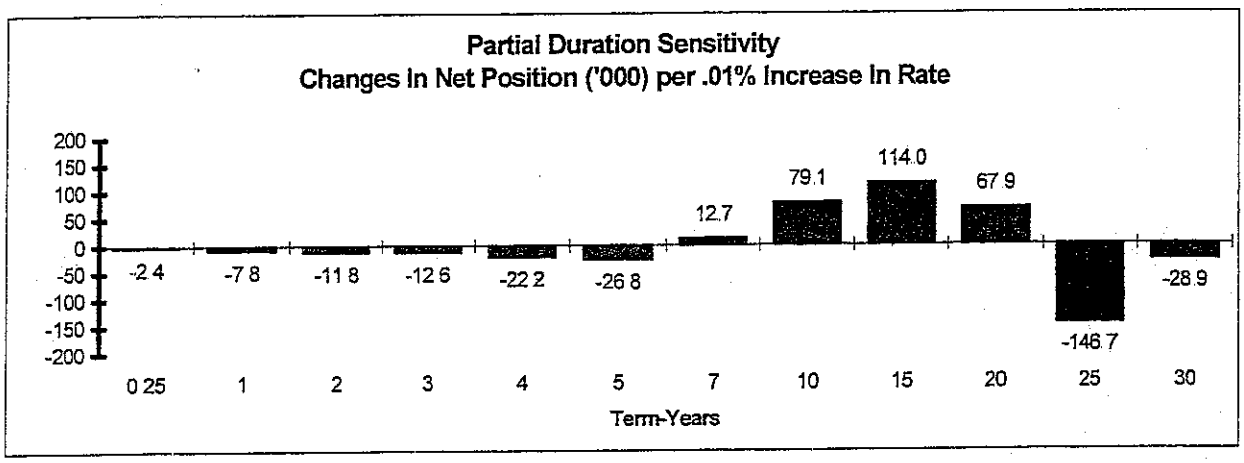
ACCUMULATION ANNUITIES

Effective Duration ***(Price Sensitivity to Parallel Shifts in the Yield Curve)***

The effective duration of assets is longer than the duration of liabilities by less than 0.01. The difference between the dollar duration of assets and liabilities is (146,000,000). This is within the approved guideline of +/- 450,000,000.

Partial Duration Sensitivity Analysis ***(Price Sensitivity to Specific Rate Changes)***

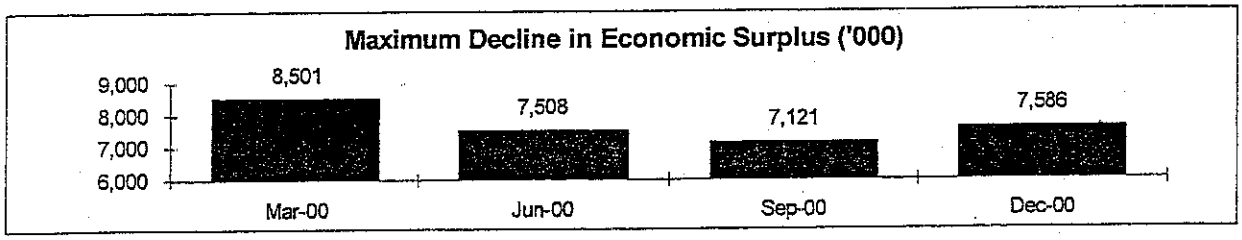
For all points along the curve partial duration sensitivities are within the approved guideline of 300,000.



Scenario Testing

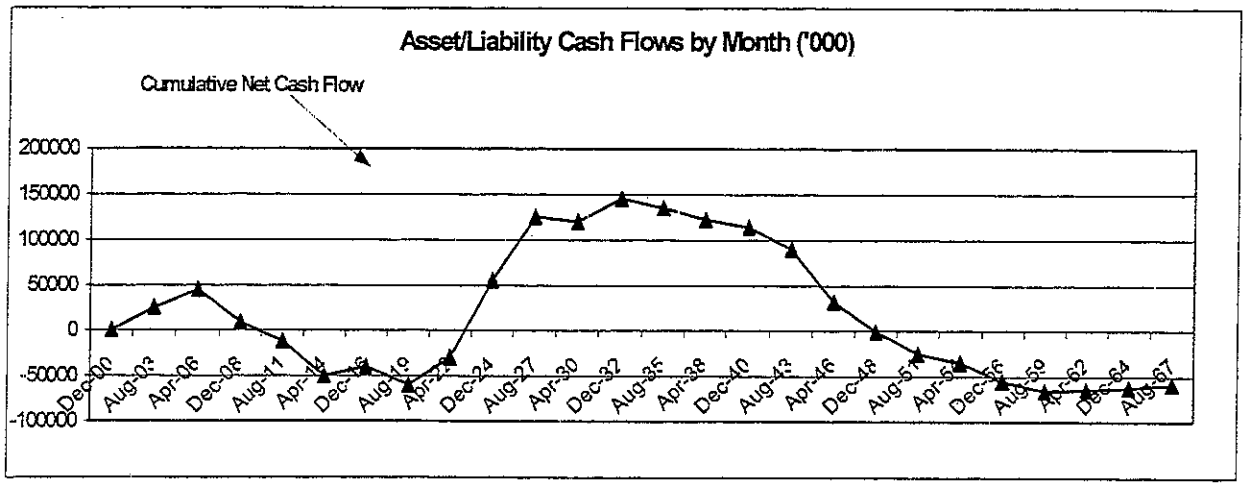
Worst Case Scenario

The worst case scenario that was tested was an increase followed by a decrease in interest rates. If this scenario were realized, it would result in a loss of $7.6 million in economic surplus.



Cash Flow Analysis

The accompanying graph does not represent actual cash outflows but rather interest rate reset dates for the assets and liabilities. No renewals or new sales are projected and asset maturities are not reinvested. Thus the usefulness of this analysis is limited to studying interest rate risk exposure. This would represent an extreme adverse scenario for measuring liquidity risk exposure.



Portfolio Rebalance

Rebalancing is performed on a monthly basis for Accumulation Annuities. At the end of December, except for cash reallocation there was no rebalancing required for Accumulation Annuities.

Asset Mix

The target mix calls for more bonds and private placements and less mortgages. The C1 capital requirement for the Accumulation Annuities portfolio excluding additional requirements for troubled assets is approximately $11.7 million at the end of December. In comparison, the C1 requirement based on the target asset mix would be $11.2 million.

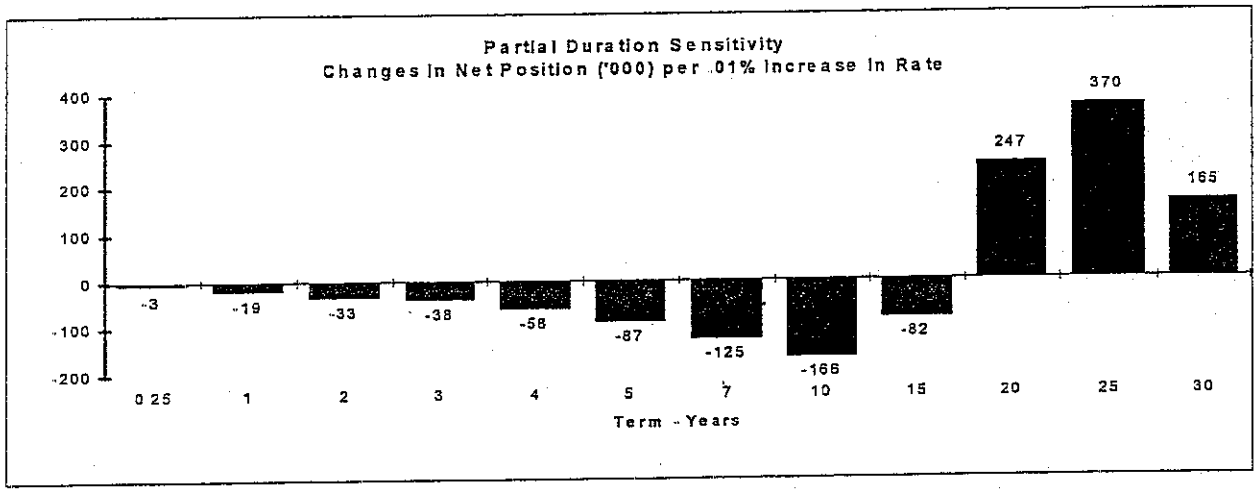
TRADITIONAL LIFE PRODUCTS

Effective Duration (Price Sensitivity to Parallel Shifts in the Yield Curve)

The effective duration of assets is shorter than the duration of liabilities by 5.2 years. This reflects the difficulty in finding assets that match the extremely long duration of the liabilities. The difference between the dollar duration of assets and liabilities is (1,710,000,000) which exceeds our approved guideline of +/- 300,000,000.

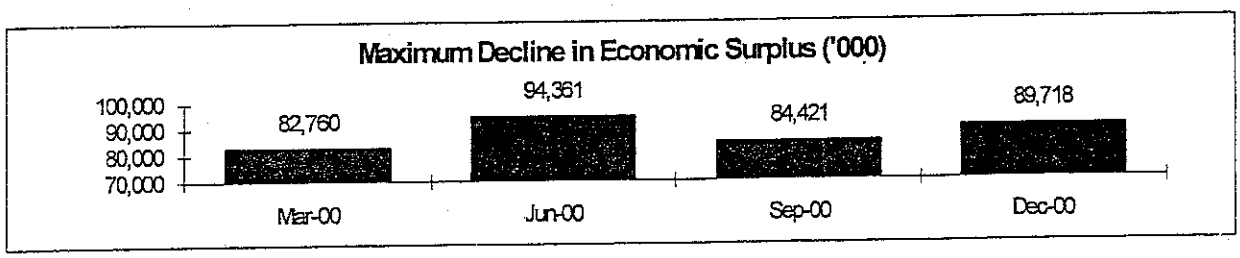
Partial Duration Sensitivity Analysis (Price Sensitivity to Specific Rate Changes)

We are exposed to rates falling at the20, 25 and 30 year terms and to rates increasing at earlier terms. Exposure is large yet exceeds guidelines of 300,000 for the 20 year term only.



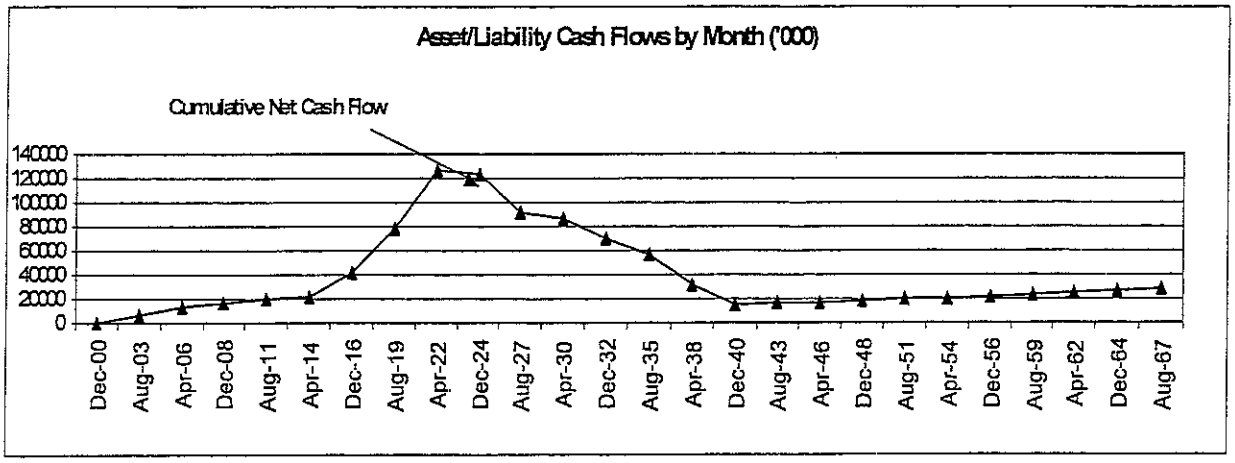
Scenario Testing

The maximum decline in economic surplus at the 95% confidence level was $89.7 million at the end of December. The scenario that gives rise to this exposure is a decrease in long term interest rates.



Cash Flow Analysis

The large positive spikes represent the maturity of the long zero coupon bonds that were purchased to extend the duration of the assets.



Portfolio Rebalance

At the end of December rebalancing was necessary as a result of the lengthening of the liabilities due to assumption changes.

Asset Mix

The target mix does not reflect policy loans, calls for more government bonds, and less private placements. The C1 capital requirement for the Traditional Life Products portfolio excluding additional requirements for troubled assets is approximately $0.5 million. In comparison, the C1 requirement based on the target asset mix would be $0.5 million. The asset mix does not reflect the assumed equity position.

NON-TRADITIONAL LIFE PRODUCTS

Projection of Cash Flows

Based on December 31 assets and liabilities, net cash flows are projected to be an average of $1.3 million per month going forward.

Margin Squeeze

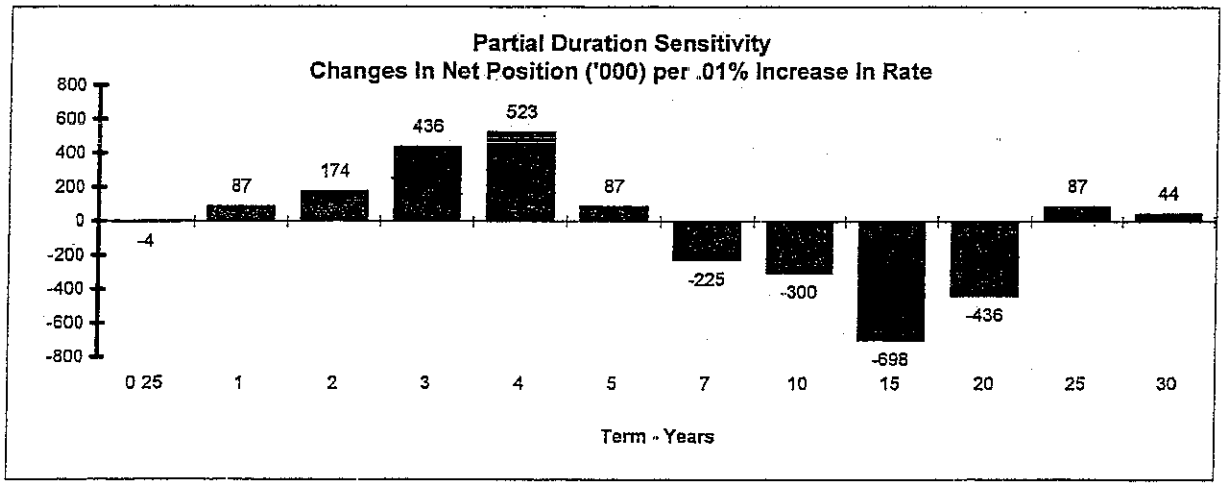
Interest sensitive cash flows have been modeled to vary for given changes in interest rates (i.e. the margin squeeze will be reflected in the price sensitivity statistics). The impact of the margin squeeze for a 1% decrease in interest rates is a $10.3 million loss in economic value.

Effective Duration (Price Sensitivity to Parallel Shifts in the Yield Curve)

The **effective** duration of assets is longer than the duration of liabilities by 5.3 years. The difference between the dollar duration of assets and liabilities is 2,235,000,000. This significantly exceeds the guideline of ± 400,000,000.

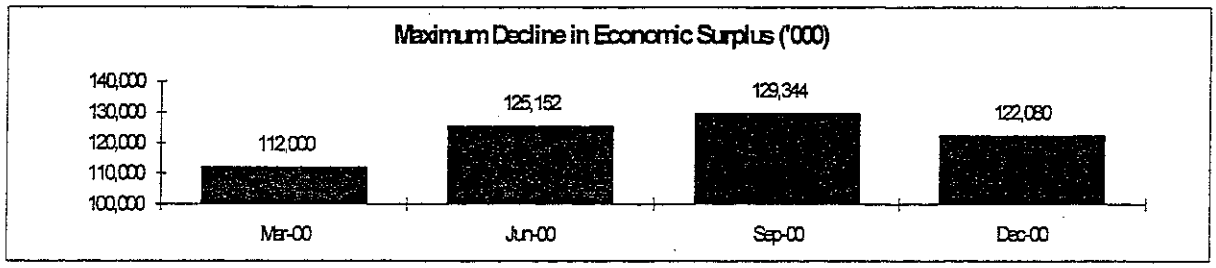
Partial Duration Sensitivity Analysis (Price Sensitivity to Specific Rate Changes)

Significant exposure exists to an increase in interest rates between the 7 and 20 year rates, a result of the duration mismatch between the assets and liabilities. The company is exposed to a decrease in interest rates for early durations. The guideline of 400,000 is exceeded in both directions for 4 points on the rate curve.



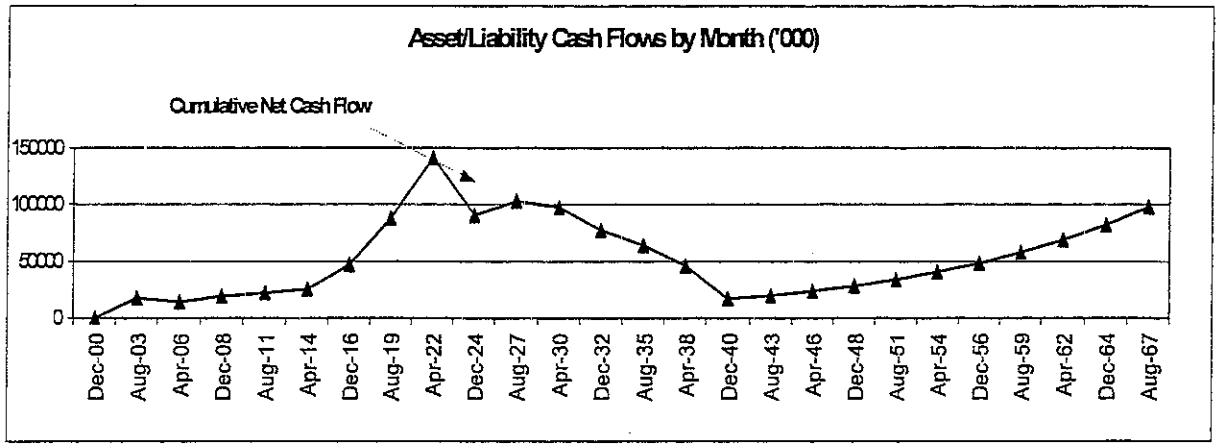
Scenario Testing

The maximum decline in economic surplus at the 95% confidence level decreased from $129.3 million to $122 1 million at the end of December. The scenario that gives rise to this exposure is a gradual decrease in long-term interest rates.



Cash Flow Analysis

Note that cash flows for both the fixed life and variable UL products are shown together.



Portfolio Rebalancing

At the end of December the need for rebalancing was identified to deal with the growing duration mismatch between assets and liabilities. Implementation was postponed due to a lack of resources to analyze and explain the mismatch.

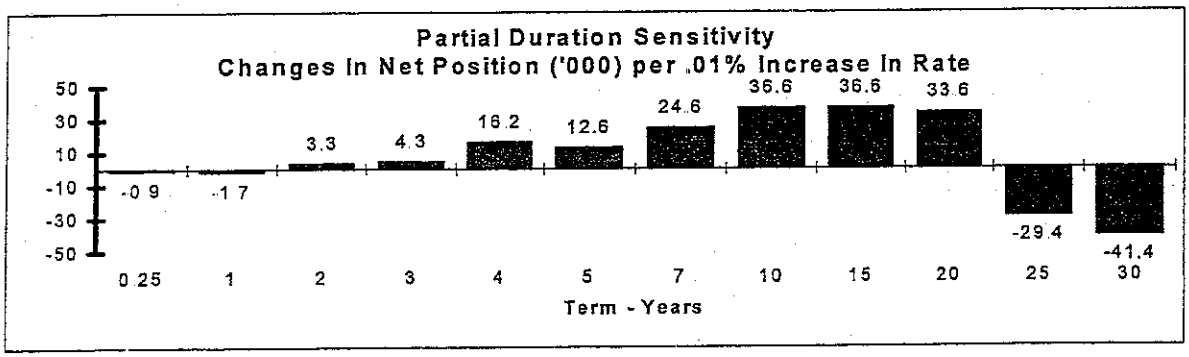
INSTITUTIONAL PENSION - PAYOUT

Effective Duration (Price Sensitivity to Parallel Shifts in the Yield Curve)

The **effective** duration of assets is shorter than the duration of liabilities by 0.80 years. The difference between the dollar duration of assets and liabilities is (675,000,000) and is within the approved guideline of ± 700,000,000.

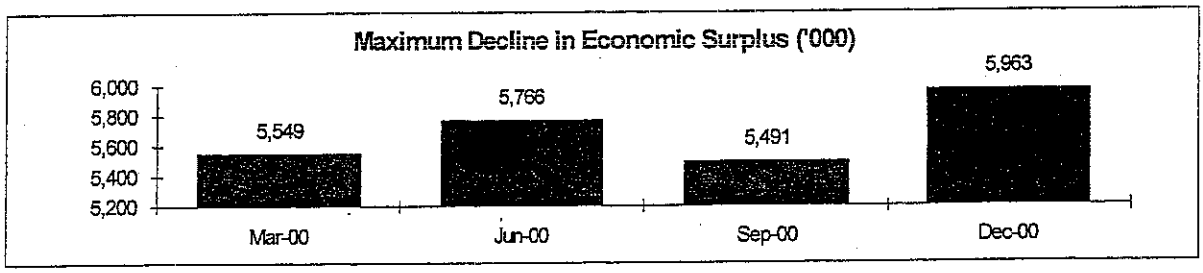
Partial Duration Sensitivity Analysis (Price Sensitivity to Specific Rate Changes)

Due to the efficiency of the immunization strategy, no significant interest rate exposure exists on that line of business.

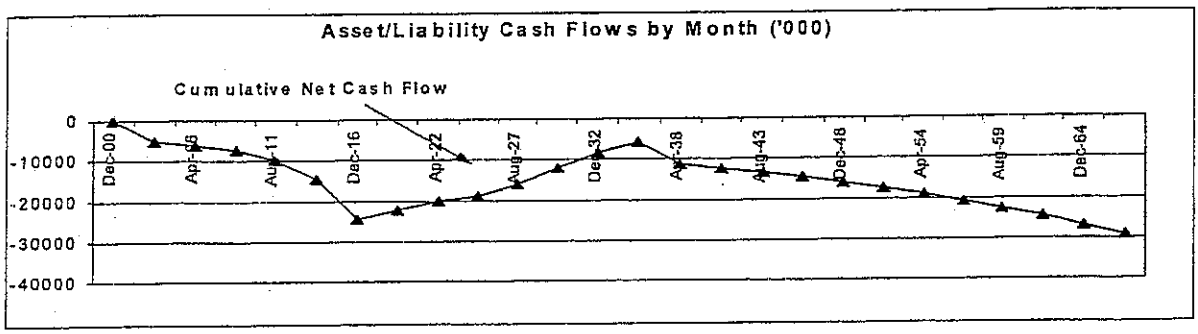


Scenario Testing

The maximum decline in economic surplus at the 95% confidence level stands at $5.96 million, and is the result of a gradually increasing interest rate for the first 20 years followed by a sharp increase.



Cash Flow Analysis



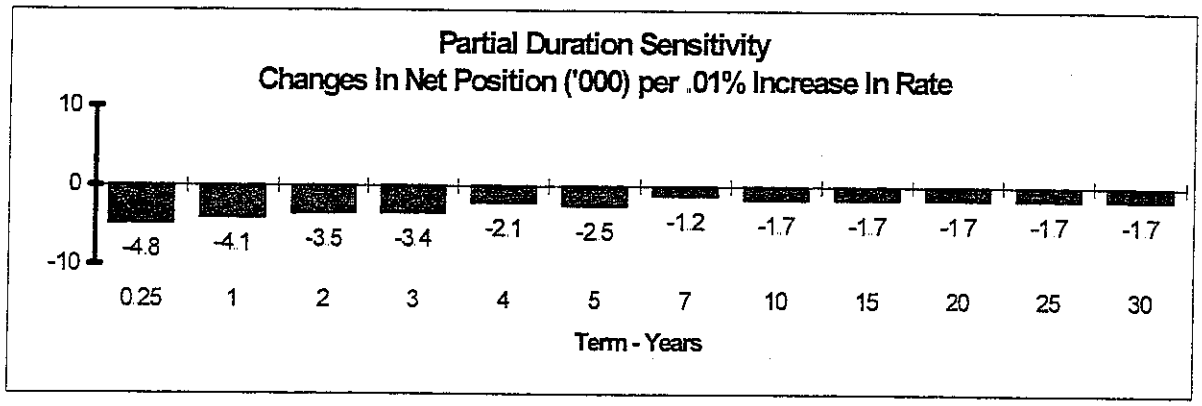
INSTITUTIONAL PENSION - GIC

Effective Duration (Price Sensitivity to Parallel Shifts in the Yield Curve)

The **effective** duration of assets is longer than the duration of liabilities by 0.20 years. The difference between the dollar duration of assets and liabilities is 300,000,000. This is within the approved guideline of ± 450,000,000.

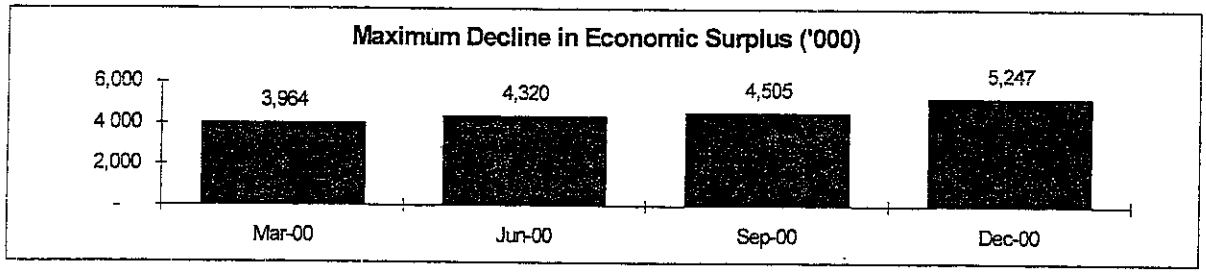
Partial Duration Sensitivity Analysis (Price Sensitivity to Specific Rate Changes)

Due to the efficiency of the immunization strategy and the short duration of the liabilities, no significant interest rate exposure exists on that line of business.

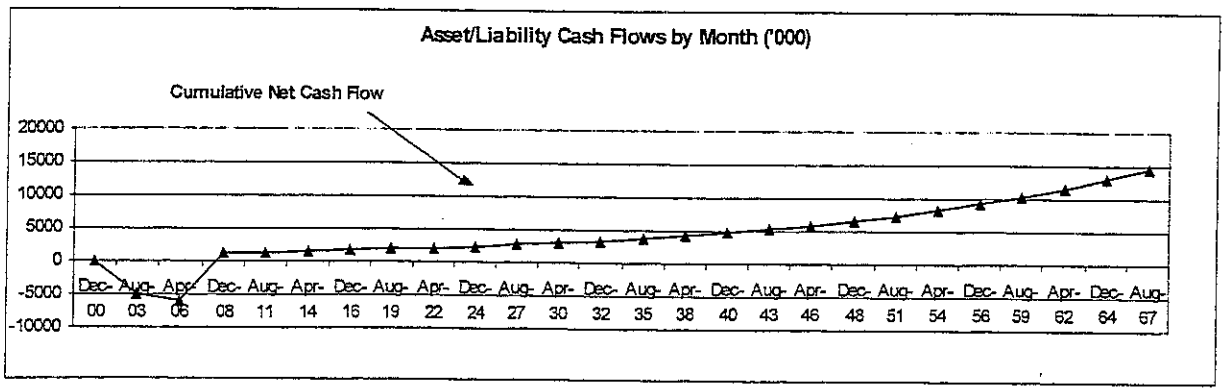


Scenario Testing

The maximum decline in economic surplus at the 95% confidence level stands at $5.2 million, and is the result of an immediate, large increase in interest rates.



Cash Flow Analysis



Currency Exposure

The Euro-denominated liabilities are valued at $100 million using exchange rates in effect as of December 31. This is approximately 20% higher than the value at last year-end. This liability exposure has not been hedged given the relatively small size of the exposure and the previously stable Euro/U.S. dollar exchange rate relationship over its short history.

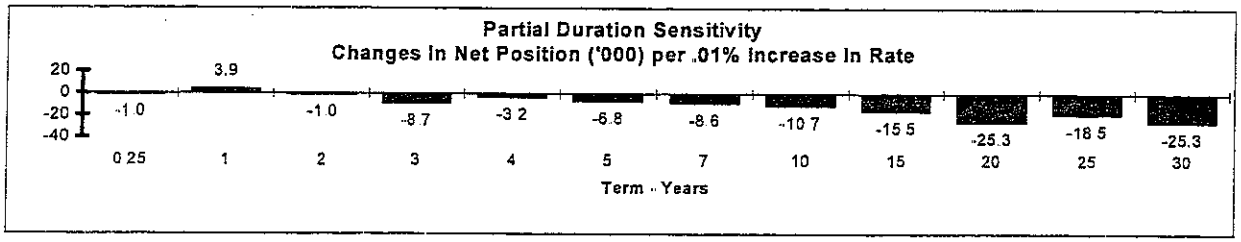
GROUP BENEFITS

Effective Duration (Price Sensitivity to Parallel Shifts in the Yield Curve)

The effective duration of assets exceeds the duration of liabilities by 1.51 year. The difference between the dollar duration of assets and liabilities is 1,206,000,000. This significantly exceeds the guideline of ± 630,000,000.

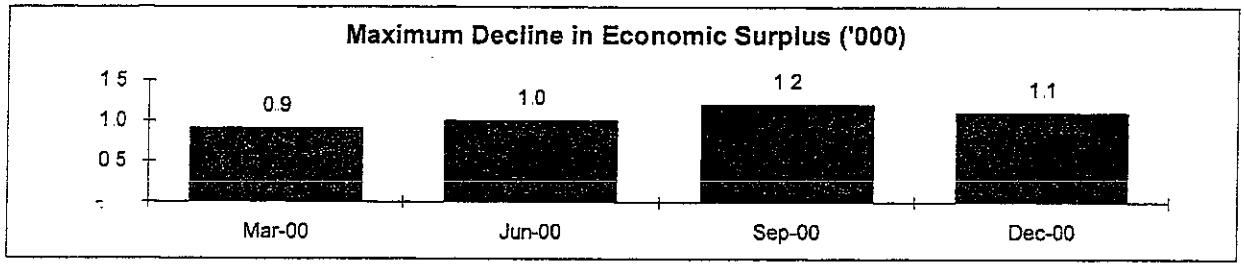
Partial Duration Sensitivity Analysis (Price Sensitivity to Specific Rate Changes)

The exposure tends to be at the longer durations, where an increase in interest rates will create a loss. All measures are within the 630,000 guideline.

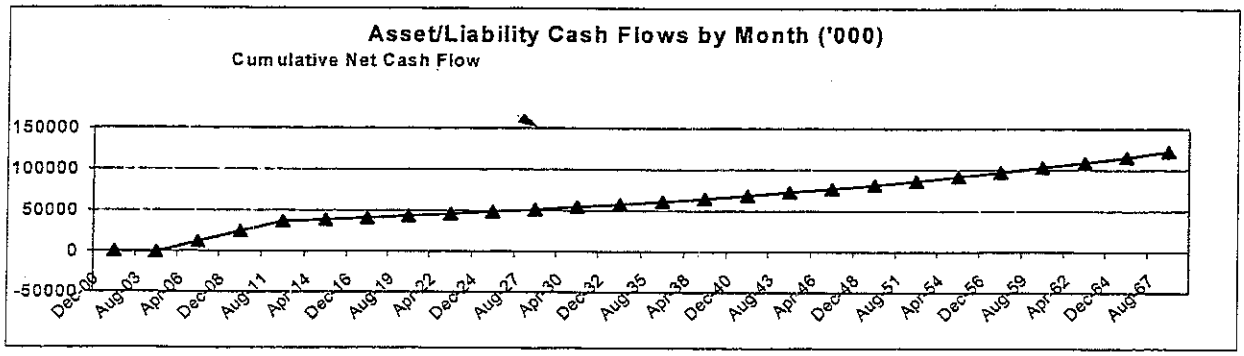


Scenario Testing

The maximum decline in economic surplus at the 95% confidence level stands at $1.1 million, and is the result of a slow decrease in interest rates.



Cash Flow Analysis



CASE STUDY INSTRUCTIONS

The case study will be used as a basis for some examination questions. Be sure to answer the question asked by referring to the case study. For example, when asked for advantages of a particular plan design to a company referenced in the case study, your response hould be limited to that company. Other advantages should not be listed, as they are extraneous to the question and will result in no additional credit. Further, if they conflict with the applicable advantages, no credit will be given.

****BEGINNING OF EXAMINATION****
EXAM FET
FINANCIAL ECONOMIC THEORY EXAM (FINANCE/ERM/INVESTMENT)
Morning Session

Questions 1 – 5 pertain to the Case Study

1. *(5 points)* LifeCo is considering selling the Traditional life insurance block. As part of the appraisal of that block, you are reporting to LifeCo's senior management on the need to consider Economic Capital.

(a) Define Economic Capital, and describe the key elements of the definition that would apply to the LifeCo Traditional block.

(b) Describe the uses of Economic Capital in appraising the Traditional block.

(c) Distinguish Economic Capital from regulatory capital.

(d) Describe the computation of Economic Capital to provide for adverse mortality and persistency for the Traditional block using a stochastic approach.

Questions 1 – 5 pertain to the Case Study

2. *(8 points)* LifeCo's ALM committee is concerned about the non-traditional life product segment's duration mismatch shown in the ALM report.

(a) Briefly describe the ALM characteristics of LifeCo's non-traditional life product liabilities.

(b) Evaluate this line's interest rate risk exposure.

(c) Assess the appropriateness of this line's asset class allocation.

(d) Explain the benefits and drawbacks of considering the ALM position of the traditional life and non-traditional life segments together.

(e) Recommend a course of action for LifeCo.

Questions 1 – 5 pertain to the Case Study

3. *(7 points)* LifeCo's ALM committee is considering hedging its currency exposure.

(a) Describe the critical factors for determining the optimal hedge ratio for the currency exposure.

(b) Compare three hedging techniques for managing currency exposures.

(c) Assess LifeCo's current currency exposure.

(d) Recommend a strategy to manage LifeCo's currency exposure and justify your recommendation.

Questions 1 – 5 pertain to the Case Study

4. *(7 points)* You are the Investment Actuary for LifeCo.

During their recent ratings review, the M&P Rating Agency expressed concerns around LifeCo's management of liquidity risk for their Traditional Life portfolio.

You have been asked by LifeCo's Chief Risk Officer to address these concerns.

(a) Define liquidity risk.

(b) Describe general considerations for assessing a company's exposure to liquidity risk.

(c) Identify specific factors for this portfolio that increase liquidity risk.

(d) A colleague has commented that liquidity risk could be mitigated simply by allocating more capital to various lines of business.

Critique this suggestion.

(e) Recommend actions to reduce the liquidity exposure for this portfolio.

Questions 1 – 5 pertain to the Case Study

5. *(7 points)* You are given the following template and supporting information.

Template

	Immediate Scenario	Ongoing Scenario
Risk-Adjusted Liquid Assets		
Risk-Adjusted Liquid Liabilities		
Liquidity Ratio		

Liability Risk Factor

Liability	Immediate Scenario (%)	Ongoing Scenario (%)
Deferred Annuities	90	100

Surrenderability Factor

Provision	Factor (%)
No surrenders allowed	0
Market value adjustment	50
Surrender charges greater than or equal to 5%	50
Surrender charges less than 5%	100
No surrender charges	100

Covariance Risk Factor

	Factor (%)
All business	70

Allowable Asset Factors

Asset Class	Immediate Scenario (%)	Ongoing Scenario (%)
Government	100	100
Public Corporate (inv. Grade)	96	100
Public Corporate (below inv. Grade)	0	25
Private Corporate (inv. Grade)	65	75
Private Corporate (below inv. Grade)	0	20
Agency Pass-throughs	90	90
CMO's	80	80
Cash and short-term	100	100
Commercial Mortgages	0	0
Equities	70	85
Real Estate	0	0
All other assets	0	0

Calculate the risk-adjusted liquidity ratio for LifeCo's Individual Accumulation Annuity segment, under both "Immediate" and "Ongoing" scenarios, using Standard & Poor's Insurance Liquidity Model for 2000. Show all work.

6. *(14 points)* Your company has a large block of variable annuity (VA) policies invested in an S&P 500 index fund. For all of these policies the ratio of the Guaranteed Minimum Maturity Benefit ("GMMB") to the current market value of the VA policy assets is the same.

You are given the following information:

Market value of the VA policy assets	450 million
GMMB of the VA policies	600 million
Time to maturity of all the policies	2 years
VA management charge	None
Expected log-return of the combined assets	9% per year
Volatility of the combined assets	22% per year
Risk free rate	5% per year continuously compounded
Mortality, lapse rates, dividends and transaction costs	None
Return on assets	Follows Geometric Brownian Motion

(a) Calculate the probability that the guarantee will be in-the-money at the maturity date.

(b) Calculate the expected payout on the GMMB (i.e. the excess of the guarantee over the market value).

Your company decides to implement a hedging program to mitigate the risk of a further decline in the market value of the combined assets until the maturity date.

(c) Calculate the theoretical cost of the OTC option that would hedge the risk using the Black-Scholes formula.

(d) Explain briefly why the hedge cost is different from the expected payout from (b) above.

6. (continued)

(e) Your company implements a dynamic delta hedging strategy with semi-annual rebalancing. The actual path of the Market Value of the VA Assets is given in the table below.

Calculate the information in the five empty cells in the table below.

Year t	Market Value of VA Assets	d_1	Delta	Stock part of Rebalanced Hedge at t	Bond Part of Rebalanced Hedge at t	Cash Flow at t
0.0	450	–0.4477		–302.76	421.30	118.54
0.5	440	–0.7380	–0.7697		469.33	
1.0	570	+0.0128	–0.4949	–282.10		7.66
1.5	550	–0.4501	–0.6737	–370.52	425.79	–13.15
2.0	520	n/a	n/a	n/a	n/a	

(f) Calculate the total discounted cost of the option hedge, given the path of the combined assets and the dynamic hedging strategy as implemented in the prior table and explain why this is different from the cost using the Black Scholes formula.

(g) Describe an approach to measure the risk for VA products using real world probabilities and risk measures.

(h) Explain the advantages and disadvantages of using the dynamic delta hedging strategy compared with not hedging the risk.

7. *(7 points)* Currently, Country X has no domestic insurance company and market. The President of Country X is considering two choices to reduce the cost of the country's financial assistance program to beneficiaries of deceased workers:

(i) Set up a state-run insurance company to provide subsidized life insurance policies to workers.

(ii) Establish an open insurance market and allow foreign insurance companies to sell life insurance policies to workers with the government subsidizing the insurance premiums.

World Life is a foreign insurance company and the sole candidate who has been offered a consulting assignment for the President prior to her decision above. World Life has two choices:

(1) Accept the consulting assignment and:

(i) If the President selects the state-run insurer option, World Life will help set up the company; or

(ii) If the President opens the domestic insurance market to foreign insurers, World Life will help draft insurance regulations.

If World Life accepts the consulting assignment, it cannot enter Country X's insurance market no matter what choice the President makes.

(2) Decline the consulting assignment and enter Country X's insurance market if there is one.

If World Life declines, the President will not consider another candidate for the consulting assignment and Country X will carry out the President's decision without foreign assistance.

In the event the President chooses the open market approach other insurance companies may enter the market along with World Life. The probability that this will occur is Z%. If this occurs, World Life's profits would be reduced by 75%.

A decision must be made in a tight time frame with no opportunity for bargaining or discussion between Country X and World Life. You are given the following projections:

7. (continued)

Effects on Country X:

Financial assistance program cost savings with state-run insurer	60
Consulting fee for World Life to help set up the state-run insurance company	35
Consulting fee for World Life to help draft insurance regulations	20
Financial assistance program cost savings if open insurance market introduced	45
Additional overhead costs at the state-run insurer if no consulting assignment is awarded	40

Profit opportunities for World Life (There are no income taxes in Country X.)

Enter the market without any competition	40
Consulting fee to set up state run insurance company	35
Consulting fee to help draft insurance regulations	20

(a) Construct a table of outcomes to model all possible scenarios, assuming no other insurers enter the open market if it is established.

(b) Distinguish dominating strategies and dominated strategies. State whether the dominance is weak or strong.

(c) Identify any Nash equilibriums.

(d) Determine whether Pareto optimality applies to the possible outcomes.

(e) Calculate the probability Z that would make the consulting assignment the dominant strategy for World Life.

8. *(5 points)* Company XYZ's Asset Liability Management Committee is currently reviewing the risk exposures of the Single Premium Deferred Annuities portfolio as described in the following excerpt from their ALM Report.

Asset Type	Market Value	Modified Duration	Effective Duration
Non-callable Government Treasuries	$10 million	0.70	0.69
Callable Corporate Bonds	$40 million	4.26	2.92
Mortgage Backed Securities	$20 million	8.23	6.57

Asset portfolio convexity = 45

Liability Information:

Line of Business	Market Value	Modified Duration	Effective Duration
Single Premium Deferred Annuities	$50 million	4.20	2.40

Liability portfolio convexity = 65

(a) Recommend a duration measure to evaluate the price sensitivity of each of the assets and the liabilities. Justify your selection.

(b) Calculate the portfolio duration of the assets based on your recommended duration measure in part (a).

(c) Assess whether this asset/liability portfolio is immunized on the dollar value of surplus basis assuming non-parallel yield curve shifts can occur. Show your work.

****END OF EXAMINATION****
MORNING SESSION