Return Models
Valuation Multiples For Banks

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In this white paper we will develop the mathematics for valuation multiples for banks using the return model discussed in previous sections. To that end we will work through the following hypothetical problem...

Our Hypothetical Problem

The table below presents XYZ Bank's go-forward model assumptions...

Table 1: Model Parameters

Symbol	Description	Balance
A_0	Tangible bank assets at time zero (in dollars)	100,000,000
R_0	Annualized operating revenue at time zero (in dollars)	5,500,000
θ	Ratio of tangible bank capital to tangible bank assets	0.0850
π	Continuous-time after-tax return on capital	0.1150
μ	Continuous-time asset growth rate	0.0500
κ	Continuous-time equity cost of capital	0.0950

We will define operating revenue to be interest income on cash, securities and loans receivable plus non-interest income.

We are tasked with answering the following questions:

Question 1: What is XYZ Bank's capital value as a multiple of tangible bank capital?
Question 2: What is XYZ Bank's capital value as a multiple of operating revenue?
Question 3: What is XYZ Bank's capital value as a multiple of operating earnings?
Question 4: Why is mean-reversion relevant to XYZ Bank?

Building Our Model

We will define the variable A_t to be tangible bank assets at time t and the variable μ to be the continuous-time asset growth rate. Using the model parameters in Table 1 above, the equation for tangible bank assets is...

$$A_t = A_0 \,\mathrm{Exp}\left\{\mu\, t\right\} \tag{1}$$

We will define the variable R_t to be annualized operating revenue at time t and the variable λ to be the ratio of annualized revenue to tangible bank assets. Using the model parameters in Table 1 above, the equation for annualized revenue is...

$$R_t = \lambda\, A_t \;\; \text{...where...} \;\; \lambda = \frac{R_0}{A_0} \tag{2}$$

We will define the variable E_t to be tangible bank capital at time t and the variable θ to be the ratio of tangible bank capital to tangible bank assets. Using Equation (1) above, the equation for tangible bank capital is...

$$E_t = \theta\, A_0 \,\mathrm{Exp}\left\{\mu\, t\right\} \tag{3}$$

The equation for the derivative of Equation (3) above with respect to time is...

$$\frac{\delta}{\delta t} E_t = \mu\,\theta\,A_0\,\mathrm{Exp}\left\{\mu\,t\right\} \text{ ...such that... } \delta E_t = \mu\,\theta\,A_0\,\mathrm{Exp}\left\{\mu\,t\right\}\delta t \tag{4}$$

We will define the variable N_t to be annualized after-tax net income at time t and the variable π to be the after-tax return on equity. Using Equations (1) and (3) above, the equation for annualized net income is...

$$N_t = \pi\,E_t = \pi\,\theta\,A_t = \pi\,\theta\,A_0\,\mathrm{Exp}\left\{\mu\,t\right\} \text{ ...where... } N_0 = \pi\,\theta\,A_0 \tag{5}$$

We will define the variable V_0 to be the market value of bank capital at time zero and the variable κ to be the continuous-time equity cost of capital. We will define cash flow to be net income (profitability) minus the change in bank capital (investment). Using Equations (4) and (5) above, the equation for enterprise value is...

$$V_0 = \int_0^\infty \left(N_t\,\delta t - \delta E_t\right)\mathrm{Exp}\left\{-\kappa\,t\right\}\delta t \tag{6}$$

Using Equations (4) and (5) above, we can rewrite Equation (6) above as...

$$\begin{aligned} V_0 &= \int_0^\infty \left(\pi\,\theta\,A_0\,\mathrm{Exp}\left\{\mu\,t\right\} - \mu\,\theta\,A_0\,\mathrm{Exp}\left\{\mu\,t\right\}\right)\mathrm{Exp}\left\{-\kappa\,t\right\}\delta t \\ &= \theta\,A_0 \int_0^\infty (\pi-\mu)\,\mathrm{Exp}\left\{\mu\,t\right\}\mathrm{Exp}\left\{-\kappa\,t\right\}\delta t \\ &= \theta\,(\pi-\mu)\,A_0 \int_0^\infty \mathrm{Exp}\left\{(\kappa-\mu)\,t\right\}\delta t \end{aligned} \tag{7}$$

The solution to Equation (7) above is...

$$\begin{aligned} V_0 &= \theta\left(\frac{\pi-\mu}{\mu-\kappa}\right)A_0\left(\mathrm{Exp}\left\{(\kappa-\mu)\times\infty\right\} - \mathrm{Exp}\left\{(\kappa-\mu)\times 0\right\}\right) \\ &= \theta\left(\frac{\pi-\mu}{\mu-\kappa}\right)A_0\Big(0-1\Big) \\ &= \theta\left(\frac{\pi-\mu}{\kappa-\mu}\right)A_0 \end{aligned} \tag{8}$$

Using Equations (1), (2), (3), and (5) above, we can rewrite Equation (8) above as...

$$V_0 = \theta\left(\frac{\pi-\mu}{\kappa-\mu}\right)A_0 = \frac{\theta}{\lambda}\left(\frac{\pi-\mu}{\kappa-\mu}\right)R_0 = \frac{1}{\pi}\left(\frac{\pi-\mu}{\kappa-\mu}\right)N_0 \tag{9}$$

Using Equation (9) above, our three enterprise value valuation multiples are...

$$\text{Capital} = \frac{\pi-\mu}{\kappa-\mu} \text{ ...and... Revenue} = \frac{\theta}{\lambda}\left(\frac{\pi-\mu}{\kappa-\mu}\right) \text{ ...and... Earnings} = \frac{1}{\pi}\left(\frac{\pi-\mu}{\kappa-\mu}\right) \tag{10}$$

Answers To Our Hypothetical Problem

Using Equation (2) above and the model parameters in Table 1 above, the equation for the model parameter λ is...

$$\lambda = \frac{R_0}{A_0} = \frac{5,500,000}{100,000,000} = 0.0550 \tag{11}$$

Question 1: What is XYZ Bank's capital value as a multiple of tangible bank capital?

Using Equation (3) above and the model parameters in Table 1 above, the equation for tangible bank capital at time zero is...

$$E_0 = \theta\, A_0 = 0.0850 \times 100,000,000 = 8,500,000 \tag{12}$$

Using Equation (10) above and the model parameters in Table 1 above, the equation for the valuation multiple of tangible bank capital (i.e. book value of common equity) is...

$$\text{Multiple of tangible bank capital} = \frac{0.1150 - 0.0500}{0.0950 - 0.0500} = 1.4444 \tag{13}$$

Using Equations (12) and (13) above, the answer to the question is...

$$V_0 = 8,500,000 \times 1.4444 = 12,277,778 \tag{14}$$

Question 2: What is XYZ Bank's capital value as a multiple of operating revenue?

Using Equations (10) and (11) above and the model parameters in Table 1 above, the equation for the valuation multiple of bank operating revenue is...

$$\text{Multiple of bank operating revenue} = \frac{0.0850}{0.0550} \times \frac{0.1150 - 0.0500}{0.0950 - 0.0500} = 2.2323 \tag{15}$$

Using Equation (15) above and the model parameters in Table 1 above, the answer to the question is...

$$V_0 = 5,500,000 \times 2.2323 = 12,277,778 \tag{16}$$

Question 3: What is XYZ Bank's capital value as a multiple of operating earnings?

Using Equation (5) above and the model parameters in Table 1 above, the equation for annualized after-tax net income at time zero is...

$$N_0 = 0.1150 \times 0.0850 \times 100,000,000 = 977,500 \tag{17}$$

Using Equation (10) and above and the model parameters in Table 1 above, the equation for the valuation multiple of annualized bank net income to common is...

$$\text{Multiple of bank earnings} = \frac{1}{0.1150} \times \left(\frac{0.1150 - 0.0500}{0.0950 - 0.0500}\right) = 12.5604 \tag{18}$$

Using Equations (17) and (18) above and the model parameters in Table 1 above, the answer to the question is...

$$V_0 = 977,500 \times 12.5604 = 12,277,778 \tag{19}$$

Question 4: Why is mean-reversion relevant to XYZ Bank?

XYZ Bank's return on equity is 11.50% and its cost of equity capital is 9.50%. In the analysis above we are assuming that the return on equity and cost of capital are static in perpetuity. In competitive economies the return on equity should mean-revert to the cost of capital over time. We are assuming that this mean reversion never happens. Note that if XYZ Bank's return on equity equaled its cost of capital then bank capital value would decrease from $12,277,778 to $8,500,000, which is the book value of the bank's capital.