9.

a.) Phases: 1. decision to borrow given r^c

2. choice of effort given r^c and r^f, r^c fixed

3. realization of project returns (given effort selected and risk type of borrower); repayment decision (strategic default ruled out by assumption 5)

b.) Backward induction $\longrightarrow$ start solving 3, then 2, then 1

c.) $\pi(\theta_i, e)$ — effort; θ_i — risk type,

assumption 3: $\frac{\partial \pi(\cdot)}{\partial \theta} < 0$

assumption 2: $\frac{\partial \pi(\cdot)}{\partial e} > 0$

If success, then due to assumption 5, loan always repaid.

d.) $$\frac{\partial \pi(\theta_i, e)}{\partial e}\left[Y(\theta_i) - 1 - r^c + C_b(r^f)\right] = 1$$

$$\frac{\partial \pi(\theta_i, e)}{\partial e} = \frac{1}{Y(\theta_i) - 1 - r^c + C_b(r^f)}$$

now, increasing r^c decreases the denominator, hence the RHS fraction increases; thus $\frac{\partial \pi(\cdot)}{\partial e} \uparrow$ w/ increasing r^c, due to assumption 2 we know that $\frac{\partial \pi(\cdot)}{\partial e} > 0$ & $\frac{\partial^2 \pi(\cdot)}{\partial^2 e} < 0$, hence we know that the higher the slope of π, the lower e has to be (concavity of $\pi(\cdot)$). Thus w/ increasing r^c, effort drops.

e.) Same argument as in (d), you just need to realize that $\frac{\partial C_b(r^f)}{\partial r^f} < 0$ $\Rightarrow$ again, denominator lower w/ increasing r^f. The rest is the same as in (d).

f.) In both cases effort decreases w/ higher rates $\Rightarrow$ default increases.

g.) Rewrite (2) as:

$$\underbrace{\tilde{\pi}(\theta_i, \hat{e})\left(Y(\theta_i)\right.}_{\text{Use assumption 4:}} - 1 - r^0 + C_b(r)\big) - e - C_b(r) \geq 0$$

$$\frac{\bar{Y}(e)}{\cancel{Y(\theta)}} \cancel{Y(\theta)} + \tilde{\pi}(\theta_i, \hat{e})\left(-1 - r^0 + C_b(r)\right) - e - C_b(r) \geq 0$$

not depends on θ anymore

Now take partial derivative w/ respect to θ:

$$\underbrace{\underbrace{\frac{\partial \tilde{\pi}(\theta_i, \hat{e})}{\partial \theta_i}}_{<0 \text{ by assumption 3}} \underbrace{\left(-1 - r^0 + C_b(r)\right)}_{\text{in (iii) we assume that } C_b(r) < 1 + r^0\text{, thus this part also negative}}}_{\text{total effect is positive}}$$

$\Rightarrow$ returns increasing in risk type, potential for sorting on risk types (here, safe borrowers might choose to stay out, depending on $C_b(r)$, $\hat{e}$, and r^0.

h.) If $r^0 \uparrow$ induces take-up by more risky types $\Rightarrow$ more defaults w/ increasing r^0