# Corporate Finance: Capital structure and managerial compensation

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# Berkovitch, Israel, and Spiegel JEMS, 1997

"Managerial Compensation and Capital Structure”

# The model

- The timing:

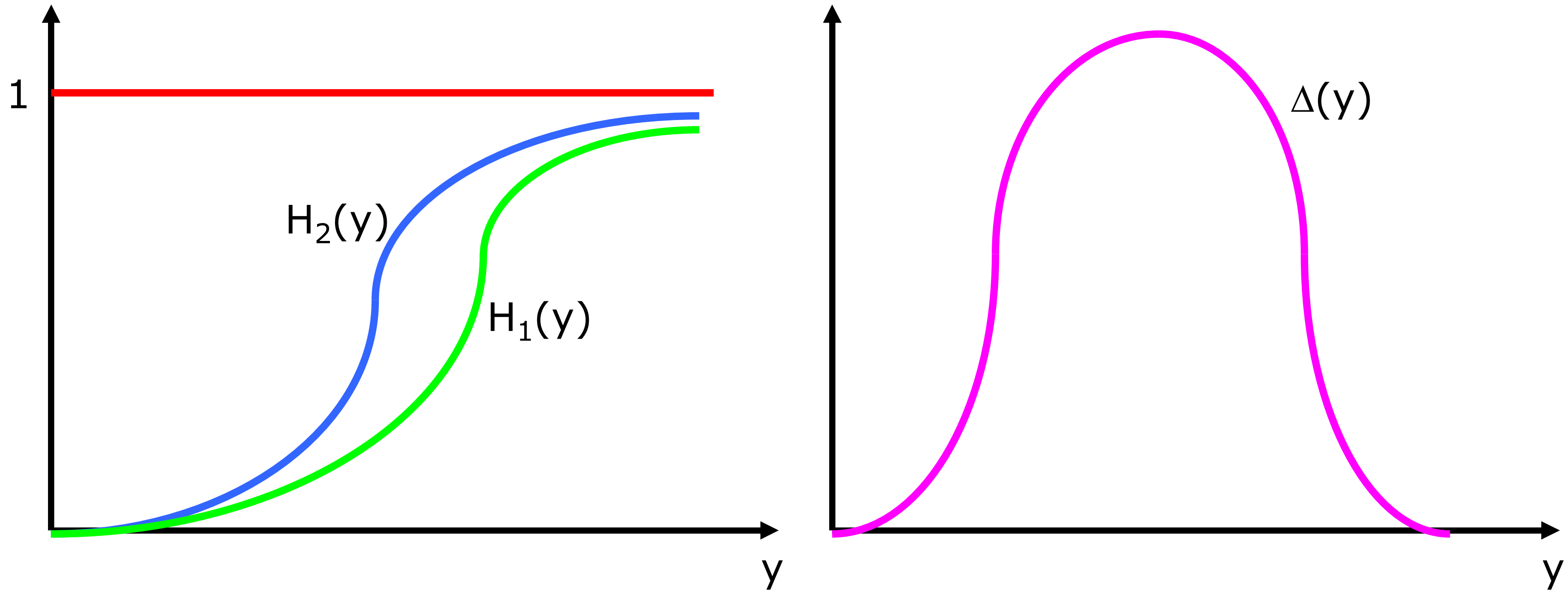
| Period 0 | Period 1 | Period 1.5 | Period 2 |
|---|---|---|---|
| A firm is established:<br>• manager is hired<br>• managerial contract<br>• debt w/ face value F | The manager exerts effort e | The firm observes signal S and then the manager is replaced or retained | Cash flow is realized |

- S is noncontractible ⇒ Managerial contract $(w_0, w_1)$
- Cash flow in period 2 under existing manager:

$$y \sim H(y \mid e) = eH_1(y) + (1-e)H_2(y)$$

- Cash flow in period 2 under a new manager: $y \sim H_3(y)$, with mean $\hat{y}$

# Period 2 cash flow




- Let $\Delta(y) \equiv H_2(y)-H_1(y)$:

$$H(y \mid e) = H_2(y) - e\Delta(y)$$

- $\Delta(y)$ is unimodal

# Managerial compensation

- Payoffs under replacement:
  - Equityholders:

$$V^r = \int_{w_0+F}^{\infty} (y - w_0 - F)\, dH_3(y)$$

  - The manager ($w_0$ is senior to F):

$$U^r = \int_0^{w_0} y\, dH_3(y) + \int_{w_0}^{\infty} w_0\, dH_3(y)$$

- The manager gets benefits of control B

# Bargaining over $w_1$

- Bargaining

Manager's TIOLI, Prob. $\gamma$ → $y\text{-}F\text{-}W^m = V^r \Rightarrow W^m = y\text{-}F\text{-}V^r$

Equityholders' TIOLI, Prob. $1\text{-}\gamma$ → $B+W^s = U^r \Rightarrow W^s = (U^r\text{-}B)^+$

- Expected wage:

$$w_1{}^* = \gamma(y - F - V^r) + (1-\gamma)\left(U^r - B\right)^+$$

- Suppose by way of negation that $U^r > B$

# Managerial replacement

- The manager's replacement:

$$y - F - w_1^* \geq V^r \quad \Rightarrow \quad y \geq V^r + F + \underbrace{\gamma(y - F - V^r) + (1-\gamma)\left(U^r - B\right)}_{w_1^*}$$

- Rearranging and using the definitions of $U^r$ and $V^r$:

$$y \geq \underbrace{V^r + F + U^r - B}_{\hat{S}} = \hat{y} - \int_{w_0}^{w_0+F} \left(y - w_0 - F\right) dH_3\left(y\right) + \int_0^{w_0} F dH_3\left(y\right) - B$$

- $w_0 \uparrow \Rightarrow \hat{S} \uparrow$:

$$\frac{\partial \hat{S}}{\partial w_0} = \int_{w_0}^{w_0+F} dH_3\left(y\right) - Fh_3\left(w_0\right) + Fh_3\left(w_0\right) = \int_{w_0}^{w_0+F} dH_3\left(y\right) > 0$$

# Managerial replacement

- The manager's payoff:

$$U(e)=\underbrace{\int_0^{\hat{S}} U^r h(y\mid e)dy}_{\text{Payoff if replaced}}+\underbrace{\int_{\hat{S}}^{\infty}(B+w_1{}^*)h(y\mid e)dy}_{\text{Payoff if retained}}-\underbrace{\psi(e)}_{\text{Cost of effort}}$$

$$=U^r+\int_{\hat{S}}^{\infty}\gamma\left(y-\hat{S}\right)h(y\mid e)dy-\psi(e)$$

- Recall that $h(y|e) = h_2(y)-e\Delta'(y)$:

$$U'(e)=-\int_{\hat{S}}^{\infty}\gamma\left(y-\hat{S}\right)\Delta'(y)dy-\psi'(e)$$

$$=\underbrace{-\gamma\left(y-\hat{S}\right)\Delta(y)\Big|_{\hat{S}}^{\infty}}_{=0}+\int_{\hat{S}}^{\infty}\gamma\Delta(y)dy-\psi'(e)$$

# Managerial replacement

- The F.O.C for the manager's payoff:

$$U'(e) = \int_{\hat{S}}^{\infty} \gamma \Delta(y) dy - \psi'(e) = 0$$

- $w_0 \uparrow \Rightarrow \hat{S} \uparrow \Rightarrow e \downarrow$ (The firm pays more and gets less effort)

$\Rightarrow$ The firm will not raise $w_0$ to the point where $U^r > B$

$\Rightarrow$ $U^r < B$

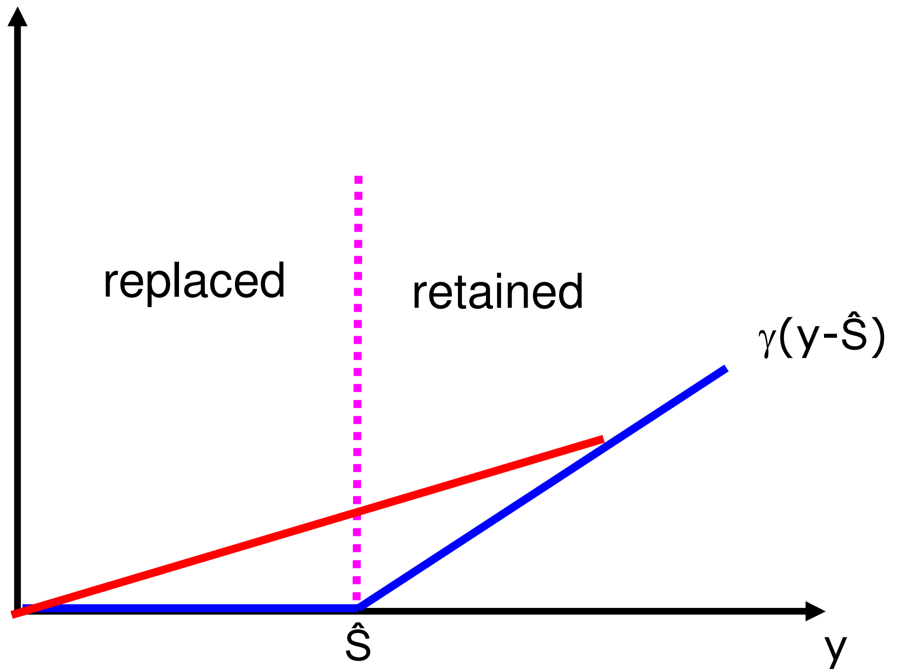
- The manager's wage:

$$w_1^* = \gamma(y - F - V^r) + (1-\gamma)(U^r - B)^+ = \gamma\left(y - \underbrace{\hat{S}}_{F+V^r}\right)$$

- Retaining the manager:

$$y - F - w_1^* \geq V^r \quad \Rightarrow \quad y - \underbrace{\gamma(y - \hat{S})}_{w_1^*} \geq \underbrace{F + V^r}_{\hat{S}} \quad \Rightarrow \quad y \geq \hat{S}$$

# Illustrating the replacement rule and the manager's compensation




- The manager's av. wage could be low even if $\gamma$ is large

# How does Ŝ vary with F and $w_0$?

$$\hat{S} \equiv V^r + F = \hat{y} - w_0 - \int_0^{w_0+F} (y - w_0 - F)\, dH_3(y)$$

$$\frac{\partial \hat{S}}{\partial w_0} = -1 + \int_0^{w_0+F} dH_3(y) = -(1 - H_3(w_0 + F)) < 0$$

$$\frac{\partial \hat{S}}{\partial F} = \int_0^{w_0+F} dH_3(y) = H_3(w_0 + F) > 0$$

- The firm is more aggressive when F is larger (why?) and softer when $w_0$ is larger

# Managerial effort

- The manager's payoff:

$$U(e) = \underbrace{\int_0^{\hat{S}} U^r h(y \mid e) dy}_{\text{Payoff if replaced}} + \underbrace{\int_{\hat{S}}^{\infty} (B + w_1^*) h(y \mid e) dy}_{\text{Payoff if retained}} - \underbrace{\psi(e)}_{\text{Cost of effort}}$$

- Recall that $h(y|e) = h_2(y) - e\Delta'(y)$:

$$U'(e) = -\int_0^{\hat{S}} U^r \Delta'(y) dy - \int_{\hat{S}}^{\infty} \left( B + \underbrace{\gamma\left(y - \hat{S}\right)}_{w_1^*} \right) \Delta'(y) dy - \psi'(e)$$

$$= -U^r \Delta\left(\hat{S}\right) - \left( \left(\left(B + \gamma\left(y - \hat{S}\right)\right) \Delta(y)\right)\Big|_{\hat{S}}^{\infty} - \int_{\hat{S}}^{\infty} \gamma \Delta(y) dy \right) - \psi'(e)$$

$$= \underbrace{\left(B - U^r\right) \Delta\left(\hat{S}\right)}_{\text{Net benefit when retained}} + \underbrace{\int_{\hat{S}}^{\infty} \gamma \Delta(y) dy}_{\text{Extra income when retained}} - \psi'(e) = 0$$

# Full differentiation

- Suppose we have a function F(x,y)=0 which defines x as a function of y

- How does x changes when y changes?

$$\frac{\partial F(x,y)}{\partial x}\partial x+\frac{\partial F(x,y)}{\partial y}\partial y=0 \quad \Rightarrow \quad \frac{\partial x}{\partial y}=-\frac{\partial F(x,y)/\partial y}{\partial F(x,y)/\partial x}$$

- If F(x,y) is F.O.C for x then $\partial F(x,y)/\partial x<0$. Hence,

$$sign\left(\frac{\partial x}{\partial y}\right)=sign\left(\frac{\partial F(x,y)}{\partial y}\right)$$

# The effect of debt on effort

- The manager's F.O.C:

$$\underbrace{\left(B-U^{r}\right)\Delta\left(\hat{S}\right)}_{\text{Net benefit when retained}} + \underbrace{\int_{\hat{S}}^{\infty}\gamma\Delta\left(y\right)dy}_{\text{Extra income when retained}} = \underbrace{\psi'(e)}_{\text{Cost of effort}}$$

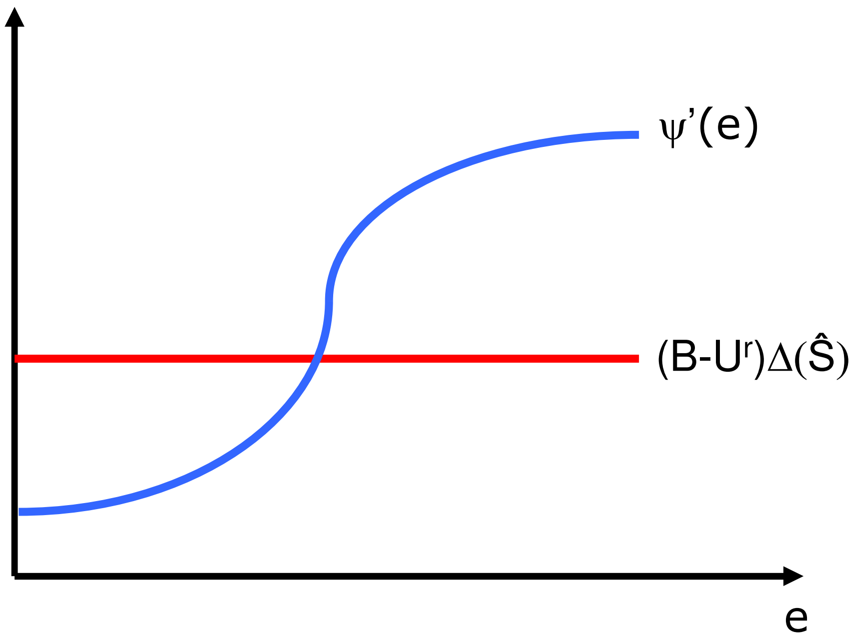
- Differentiating w.r.t e and F:

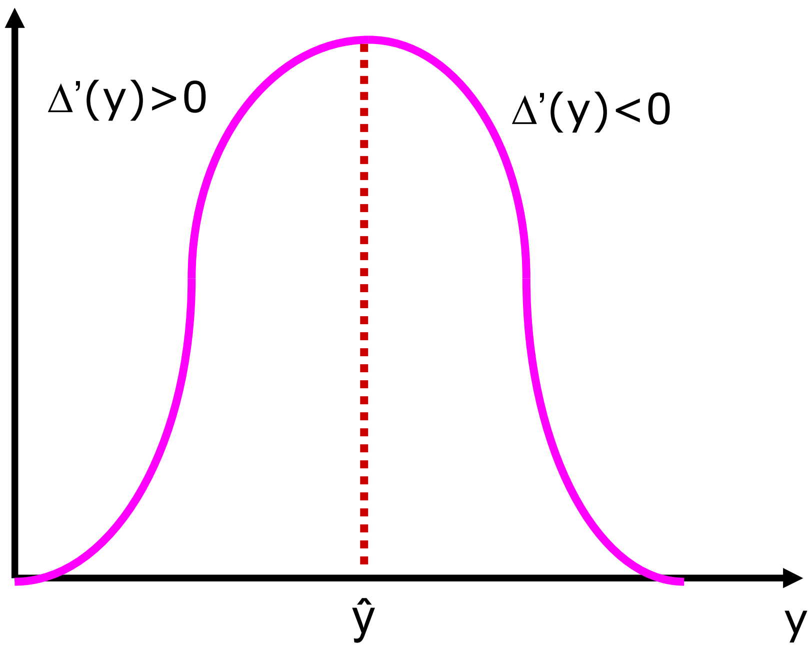
$$\frac{\partial e^{*}}{\partial F} = \frac{\overbrace{\left(B-U^{r}\right)}^{(+)}\overbrace{\Delta'\left(\hat{S}\right)}^{?}-\overbrace{\gamma\Delta\left(\hat{S}\right)}^{(+)}}{\underbrace{\psi''(e^{*})}_{(+)}} \times \underbrace{\frac{\partial \hat{S}}{\partial F}}_{(+)}$$

- $\gamma\Delta(\hat{S})$ is "free cash flow" effect – negative
- $(B-U^{r})\Delta'(\hat{S})$ is "job security" effect - ambiguous

$\Rightarrow$ F↑ $\Rightarrow$ e*↑ iff the "job security" effect is positive and large

# Illustrating the job security effect




- The "job security" effect is:
  - Positive if Ŝ < ŷ
  - Negative if Ŝ > ŷ

# The effect of $w_0$ on effort

- The manager's F.O.C:

$$\underbrace{(B - U^r)\Delta(\hat{S})}_{\text{Net benefit when retained}} + \underbrace{\int_{\hat{S}}^{\infty} \gamma\Delta(y)dy}_{\text{Extra income when retained}} = \underbrace{\psi'(e)}_{\text{Cost of effort}}$$

- Differentiating w.r.t e and $w_0$:

$$\frac{\partial e^*}{\partial w_0} = \underbrace{\frac{\overbrace{(B - U^r)}^{(+)}\overbrace{\Delta'(\hat{S})}^{?} - \overbrace{\gamma\Delta(\hat{S})}^{(+)}}{\underbrace{\psi''(e^*)}_{(+)}} \times \underbrace{\frac{\partial \hat{S}}{\partial w_0}}_{(-)}}_{\text{-sign}\left(\frac{\partial e^*}{\partial F}\right)} + \underbrace{\frac{\overbrace{\Delta(\hat{S})}^{\frac{\partial e^*}{\partial U^r}>0}}{\underbrace{\psi''(e^*)}_{(+)}} \times \underbrace{\frac{\partial U^r}{\partial w_0}}_{(+)}}_{(+)}$$

- $F > 0 \Rightarrow w_0 = 0$, but $F = 0$ does not necessarily imply $w_0 > 0$

$\Rightarrow$ The firm never issues debt and gives golden parachute simultaneously

# The choice of F

- The firm's value:

$$V = \underbrace{\int_0^{\hat{S}} \left(\hat{y} - U^r\right) h\left(y \mid e^*\right) dy}_{\text{Payoff if replaced}} + \underbrace{\int_{\hat{S}}^{\infty} \left( y - \overbrace{\gamma\left(y - \hat{S}\right)}^{w_1^*} \right) h\left(y \mid e^*\right) dy}_{\text{Payoff if retained}}$$

- F affects V only through Ŝ (recall that $h(y|e) = h_2(y) - e\Delta'(y)$):

$$\frac{\partial V}{\partial \hat{S}} = \underbrace{\left(\hat{y} - U^r\right) h(\hat{S} \mid e^*)}_{\text{Replacement}\uparrow} - \underbrace{\hat{S} h(\hat{S} \mid e^*)}_{\text{Replacement}\uparrow} + \underbrace{\int_{\hat{S}}^{\infty} \gamma h(y \mid e^*) dy}_{\text{Free cash flow}\downarrow}$$

$$+ \underbrace{\left[ -\int_0^{\hat{S}} \left(\hat{y} - U^r\right) \Delta'(y) dy - \int_{\hat{S}}^{\infty} \left(y - \gamma\left(y - \hat{S}\right)\right) \Delta'(y) dy \right]}_{\frac{\partial V}{\partial e^*}} \frac{\partial e^*}{\partial \hat{S}}$$

# The choice of F:

- Rewriting ∂V/∂Ŝ :

$$\frac{\partial V}{\partial \hat{S}} = \underbrace{\left(\hat{y} - U^r - \hat{S}\right)h(\hat{S} \mid e^*)}_{\text{Replacement}\uparrow} + \underbrace{\int_{\hat{S}}^{\infty} \gamma h(y \mid e^*)dy}_{\text{Free cash flow}\downarrow}$$

$$+ \underbrace{\left[ -\left(\hat{y} - U^r\right)\Delta(\hat{S}) - \left( \left(y - \gamma\left(y - \hat{S}\right)\right)\Delta(y)\Big|_{\hat{S}}^{\infty} - \int_{\hat{S}}^{\infty} (1-\gamma)\Delta(y)dy \right) \right]}_{\frac{\partial V}{\partial e^*}} \times \frac{\partial e^*}{\partial \hat{S}}$$

$$= \left(\hat{y} - U^r - \hat{S}\right)h(\hat{S} \mid e^*) + \int_{\hat{S}}^{\infty} \gamma h(y \mid e^*)dy$$

$$+ \left[ -\left(\hat{y} - U^r\right)\Delta(\hat{S}) - \hat{S}\Delta(y)\Big|_{\hat{S}}^{\infty} + \int_{\hat{S}}^{\infty} (1-\gamma)\Delta(y)dy \right] \times \frac{\partial e^*}{\partial \hat{S}}$$

# The case where $\gamma$ = 0 (only the job security effect is present):

- If $\gamma = 0$:

$$\frac{\partial V}{\partial \hat{S}} = \left(\hat{y} - U^r - \hat{S}\right) h(\hat{S} \mid e^*) + \left[ -\left(\hat{y} - U^r - \hat{S}\right)\Delta(\hat{S}) + \int_{\hat{S}}^{\infty} \Delta(y)dy \right] \times \frac{\partial e^*}{\partial \hat{S}}$$

- Evaluating at F = $w_0$ = 0:

$$\left.\frac{\partial V}{\partial \hat{S}}\right|_{F=w_0=0} = \underbrace{\left( \hat{y} - \underbrace{U^r}_{=0} - \underbrace{\hat{S}}_{=\hat{y}} \right) h(\hat{S} \mid e^*)}_{=0} + \left[ \underbrace{-\left(\hat{y} - U^r - \hat{S}\right)\Delta(\hat{S})}_{=0} + \int_{\hat{S}}^{\infty} \Delta(y)dy \right] \times \left.\frac{\partial e^*}{\partial \hat{S}}\right|_{F=w_0=0}$$

$$= \int_{\hat{y}}^{\infty} \Delta(y)dy \times \frac{B\Delta'\left(\hat{y}\right)}{\psi''(e^*)} > 0$$

⇒ $\Delta'(\hat{y}) > 0 \Rightarrow F^* > 0$ and $w_0 = 0$

⇒ $\Delta'(\hat{y}) < 0 \Rightarrow F^* = 0$ and $w_0 > 0$ if B is large

# The case where $\Delta = 0$ (only the cash flow effect is present):

- If $\Delta = 0$:

$$\frac{\partial V}{\partial \hat{S}} = \left(\hat{y} - U^r - \hat{S}\right) h_2(\hat{S} \mid e^*) + \int_{\hat{S}}^{\infty} \gamma h_2(y \mid e^*)\, dy$$

- Evaluating at $F = w_0 = 0$:

$$\left.\frac{\partial V}{\partial \hat{S}}\right|_{F=w_0=0} = \underbrace{\left(\hat{y} - \underbrace{U^r}_{=0} - \underbrace{\hat{S}}_{=\hat{y}}\right) h_2(\hat{S} \mid e^*)}_{=0} + \int_{\hat{S}}^{\infty} \gamma h_2(y)\, dy$$

$\Rightarrow \gamma > 0 \Rightarrow F^* > 0$ and $w_0 = 0$

- If $\gamma\uparrow$ then $F^*\uparrow$

# Price reactions

- Managerial replacement is bad news (it means that $y < \hat{S}$) while managerial retention is good news (it means that $y \geq \hat{S}$)
  - Khanna and Poulsen (*JF*, 1995): changes in top management lead to a negative price reaction, especially in firms that end up filing for 11
  - If earnings are serially correlated, then lower current earnings (proxy for $\hat{S}$) are associated with a higher prob. of managerial replacement - Hermalin and Weisbach (*RJE*, 1988), Warner et al. (*JFE*, 1988), Weisbach (*JFE*, 1988), Kaplan and Minton (JFE, 1994)

- Firms which retain their managers have on av. higher cash flows than firms that replace their managers (the av. cash flow of firms that replace their managers is $\hat{y} < \hat{S}$)
  - Murphy and Zimmerman (*JAE*, 1993): the market-adjusted growth rates of sales decline significantly prior to CEO departures and remain negative for several years following the departure
  - Kang and Shivdasani (*JFE*, 1997): industry-adjusted ROA of non-financial Japanese firms was negative in the 3 years prior to a nonroutine managerial turnover