Career Choices and Concerns

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- This lecture extends the previous one by developing a generalized *Roy model*:
  - in a *dynamic* setting.
  - where there is one *principal* and *multiple agents* in each firm.
  - Each agent has several *employment choices*,
  - and accumulates *human capital*.
- We apply this model to managerial compensation:
  - estimating the three measures of moral hazard defined in the previous lecture.
  - to explain **why executives in large firms are paid more than those in small firms**.

Data

Sources and summary statistics (Gayle, Golan and Miller, 2012)

- Data taken from ExecuComp for the S&P 1500 and COMPUSTAT were matched with data from Who's Who for the years 1992-2006:
  - 16,300 executives (from 30,614) in 2100 firms (from 2818) yielding 59,066.
- Information on executives includes:
  - compensation, title, including interlock status, age, gender, education, annual transitions by title and firm.
- Information on firms include:
  - annual financial return, size by total assets (*large, medium, small*) and sector (*primary, service, consumer*).
- Summarizing some aggregates:
  1. The executive exit rate is between 12% and 18% per year.
  2. Turnover is about 2% to 3% per year.
  3. Executives average between 51 and 54 years old.
  4. On average executives have about 13 to 14 years firm tenure.
  5. They average about 17 years executive experience.
  6. About 80% graduated from college and about 20% have an MBA.
  7. Total compensation averages between $1.5 and $4.5 million.
  8. Compensation increases with firm size.

Compensation, education and tenure by firm size (Figures 1 and 2, GGM 2015, pages 2302-2303)

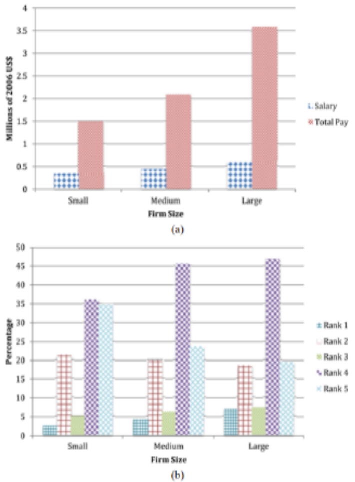

FIGURE 1.—Pay and hierarchy by firm size. (a) Firm size pay premium, (b) hierarchy by firm size.

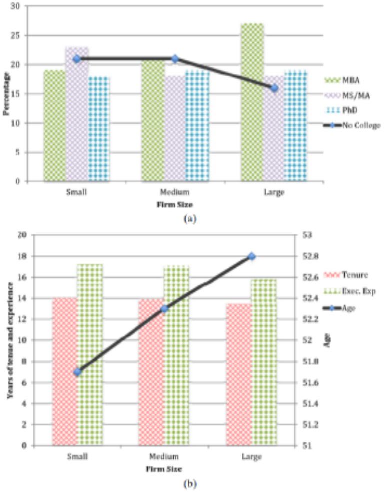

FIGURE 2.—Education and experience by firm size. (a) Education and firm size, (b) experience and firm size.

Data

What explains firm-size pay premium in the market for top executives?

- There are two fundamental factors that might be playing a role:
  1. **Human Capital**:
     1. Executives in large firms are older, more educated, but have less executive experience and less tenure than those in smaller firms; presumably human capital of the kind described by Mincer (1974) is playing a role.
     2. Working as executives in more firms increases an executive compensation at higher ranks in the hierarchy. This is a form of productivity enhancing on-the-job experience.
  2. **Moral Hazard**:
     1. Top executives are paid a significant portion of their total compensation in stock and options.
     2. The composition of firm denominated securities varies substantially across ranks and executives at different points in their lifecycle.

Model
Overview

- Firm governance is modeled as a multilateral contract between a *value maximizing principal* and *risk averse agents*:
  1. The principal is a the board of directors representing shareholders.
  2. The agents are executives are
     - at in different positions that determine their span of control over the firm's outcomes.
     - maximizing expected lifetime utility by responding to incentives and market opportunities.
- Following the literature on managerial compensation markets are incomplete because executive action is noncontractable.
- This creates a standard moral hazard problem . . .
  - solved with a second best incentive contract.

Model

Choices

- Each period while employed the executive chooses
  - consumption $c_t \in \mathcal{R}$
  - a job $d_{jkt} \in \{0, 1\}$
  - and (if s/he does not retire) effort $l_t \in \{0, 1\}$
- where:
  - $k \in \{0, \ldots, K\}$ denotes job rank.
  - $j \equiv j_1 \otimes j_2$
  - $j_1 \in \{0, 1\}$ where $d_t^{(1)} = 0$ ($d_t^{(1)} = 1$) denotes (not) quitting the firm.
  - $j_2 \in \{1, 2..., J_2\}$ denotes firm size and industrial sector.
  - s/he retires by setting $d_{0t} = 1$.
- subject to the restrictions that for all $d_t \equiv (d_{0t}, d_{11t}, \ldots, d_{JKt})$:

$$d_{0t} + \sum_{j=1}^{J} \sum_{k=1}^{K} d_{jkt} = 1$$

Model

Human capital

- $h_t \equiv (t, d_{t-1}, h_0, h_{1t}, h_{2t}, h_{3t})$ denotes human capital vector where:
  - h_0 is a fixed set of individual characteristics including gender and education
  - h_{1t} is total number of years working for firm as an executive (internal capital)
  - h_{2t} is total number of years working as an executive (general capital)
  - h_{3t} is number of firms worked in as an executive (external capital)
- The executive:
  1. loses all his internal capital unless s/he remains with the firm (both):
  $$h_{1,t+1} = d_t^{(1)} (1 + h_{1t})$$
  2. adds to his general capital by not quitting:
  $$h_{2,t+1} \equiv h_{2t} + (1 - d_{0t})$$
  3. adds to his external capital by switching firms:
  $$h_{3,t+1} = h_{3t} + \left(1 - d_t^{(1)}\right)$$
- Define $\underline{H}(h_t)$ as human capital in $t+1$ from shirking in t, and $\overline{H}_j(h_t)$ as human capital from working.

Model

Preferences and budget constraint

- Lifetime utility of an executive is parameterized as:

$$-\sum_{t=1}^{\infty}\sum_{j=0}^{J}\sum_{k=1}^{K}\delta^{t}e^{-\gamma c_t-\varepsilon_{jkt}}d_{jkt}\left[\alpha_{jk}\left(h_t\right)l_t+\beta_{jk}\left(h_t\right)\left(1-l_t\right)\right]$$

  where:

  - we abbreviate by setting $d_{0kt}\equiv d_{0t}$ for all k.
  - c_t is consumption at time t.
  - δ is the subjective discount factor.
  - γ denotes the coefficient of absolute risk aversion.
  - $\alpha_{jk}\left(h_t\right)$ is a preference parameter for working.
  - $\beta_{jk}\left(h_t\right)$ is a preference parameter for shirking.
  - Utility depends on h_t and:

$$\alpha_{jk}\left(h_t\right)>\beta_{jk}\left(h_t\right)>0$$

- An *iid* firm-job privately observed T1EV taste shock ε_{jkt} also affects utility.
- There are complete markets for all publicly disclosed events, but no borrowing against future executive compensation.

- Firm production is defined as:

$$\sum_{k=1}^{K} F_{jkt(\tau)}\left(h_{t(\tau)}\right) + e_{j\tau}\left(\pi_{\tau+1} - 1\right) + e_{j\tau}\pi_{j,\tau+1}$$

  where for expositional ease, each executive holds a distinct position and:
  - $t(\tau)$ is the age of executive at calendar time τ
  - h_t denotes the human capital of the executive
  - $F_{jk,t(\tau)}\left(h_{t(\tau)}\right)$ denote the individual contribution of k to the firm
  - $e_{j\tau}$ denotes the value of firm j at the beginning of calendar time τ
  - $\pi_{\tau+1}$ denotes the gross returns to the market portfolio
  - $\pi_{j,\tau+1}$, denotes abnormal return to the firm before executive compensation.
- We assume the probability density for $\pi_{j,\tau+1}$ is:
  - $f_j(\pi_{j,\tau+1})$ when all K executives work
  - $f_j(\pi_{j,\tau+1})g_{jk}(\pi_{j,\tau+1} | h_t)$ when all executives but k work.
- The gross expected return to a firms are higher if everybody works:

$$\int \pi f_j(\pi)\, d\pi > \int \pi f_j(\pi)\, g_{jk}(\pi | h_t) d\pi$$

Model

Timing, information, and overview of perfect equilibrium

1. Each executive knows his/her h_t and privately chooses consumption c_t.
2. Then s/he privately observes ε_{jkt} and selects a firm and position.
3. Executives in each firm simultaneously submit compensation proposals, w_{jkt+1}, to the shareholder board.
4. If proposal is off the equilibrium path, shareholders believe the worst and reject all the submissions.
5. This rejection is observed by all firms.
6. If their demands are not approved, the executives in the firm retire.
7. If approved, the executives privately choose l_t.
8. h_t is updated with $\underline{H}(h_t)$ or $\overline{H}(h_t, d_t)$.
9. The equilibrium optimal contract induces executives to work.

Firm and Job Choices

Indexing the value of human capital

- Recursively define $A_t(h)$ an index of human capital by:

$$
\begin{aligned}
A_t(h) &= p_{0t}(h)\, E\left[\exp\left(-\varepsilon^*_{0t}/b_t\right)\right] \\
&\quad + \sum_{j=1}^{J}\sum_{k=1}^{K}\left(\begin{array}{c} p_{jkt}(h)\left[\alpha_{jkt}(h)\right]^{\frac{1}{b_t}} E\left[\exp\left(-\varepsilon^*_{jkt}/b_t\right)\right] \\ \times\left\{A_{t+1}\left[H_{jk}(h)\right] E_t\left[\upsilon_{jk,t+1}\right]\right\}^{1-\frac{1}{b_t}} \end{array}\right)
\end{aligned}
$$

  where:

  - b_t is the bond price at t.
  - $\upsilon_{jk,t+1} = \exp\left(-\gamma w_{jk,t+1}/b_{t+1}\right)$
  - ε^*_{jkt} is the value of the private disturbance ε_{jkt} conditional on $d_{jkt} = 1$.
  - $p_{jkt}(h)$ is the CCP for choosing rank k in firm j, period t.

- Lower values of $A_t(h)$ are associated with higher values of human capital.
- Defining $\Gamma[\cdot]$ as the complete gamma function, if ε_{jkt} is distributed T1EV then:

$$A_t(h) = p_{0t}(h)\,\Gamma\left[1 + \frac{1}{b_{t+1}}\right] \tag{1}$$

- The value function is derived in two steps, solving for:
  1. optimal consumption given any career path
  2. the optimal career path.
- In the second step jobs are chosen to maximize:

$$\sum_{j=0}^{J} \sum_{k=0}^{K} d_{jkt} \left\{ \varepsilon_{jkt} - \ln \alpha_{jkt}(h) - (b_t - 1) \left(\ln A_{t+1}\left(H_{jk}(h)\right) + \ln E_t[v_{jk,t+1}] \right) \right\} \tag{2}$$

- Executives trade off jobs based on three dimensions:
  1. nonpecuniary benefit, $\alpha_{jkt}(h)$;
  2. human-capital accumulation, $H_{jk}(h) - h$;
  3. expected utility from compensation, $E_t[v_{jk,t+1}]$.

Cost Minimization

Participation constraint

- By the inversion theorem (Hotz and Miller 1993) there exists $q(p)$ to R^{JK} such that:

$$q_{jk}\left[p_t(h)\right] = \ln\left[\alpha_{jkt}(h)\right] + (b_t - 1)\left\{\ln A_{t+1}\left(H_{jk}(h)\right) + \ln E_t[v_{jk,t+1}]\right\} \tag{3}$$

where $q_{jk}\left[p_t(h)\right] \equiv \varepsilon'_{jkt} - \varepsilon'_{0t}$, for all shock pairs $\left(\varepsilon'_{0t}, \varepsilon'_{jkt}\right)$ making the executive indifferent between retiring and (j,k).

- Define $w^*_{jk,t+1}(h)$ as the certainty equivalent wage to a executive indifferent between $(j.k)$ and retirement given CCPs $p_t(h)$:

$$q_{jk}\left[p_t(h)\right] = \ln\alpha_{jkt}(h) + (b_t - 1)\left\{\begin{array}{l} \ln A_{t+1}\left(H_{jk}(h)\right) \\ + \ln E_t[\exp\left(-\gamma w^*_{jk,t+1}(h)/b_{t+1}\right)] \end{array}\right\}$$

- Solving for $w^*_{jk,t+1}(h)$ gives the participation constraint:

$$w^*_{jk,t+1}(h) = \frac{b_t}{\gamma}\left\{\frac{1}{(b_t-1)}\ln\alpha_{jkt}(h) + \ln A_{t+1}\left[H_{jk}(h)\right] - \frac{1}{(b_t-1)}q_{jk}\left[p_t(h)\right]\right\}$$

Cost Minimization

Incentive compatibility constraint

- One-period (short term) contracts are optimal in this model. (See Fudenberg, Holmstrom and Milgrom, 1990.)
- In this model the firm can deter shirking in a one-period contract by offering a compensation schedule that satisfies the incentive-compatibility constraint:

$$\left[\frac{\alpha_{jkt}(h)}{\beta_{jkt}(h)}\right]^{1/(b_t-1)} \leq \frac{E_t\left[v_{jk,t+1}g_{jkt}(\pi \mid h)\right]}{E_t\left[v_{jk,t+1}\right]}. \tag{4}$$

- Paying the manager a constant wage, such as $w^*_{jk,t+1}(h)$, simplifies the right side of the (4) to:

$$\frac{\exp\left(-\gamma w^*_{jk,t+1}(h)/b_{t+1}\right) E_t\left[g_{jkt}(\pi \mid h)\right]}{\exp\left(-\gamma w^*_{jk,t+1}(h)/b_{t+1}\right)} = 1, \tag{5}$$

- Since $\alpha_{jkt}(h) > \beta_{jkt}(h)$, the inequality given by (4) is violated: paying a constant wage guarantees shirking in this model.

Cost Minimization

Optimal Contract (Theorem 4.3 of GGM 2015)

- The cost minimizing contract is:

$$
\begin{aligned}
w_{jk,t+1}(h,\pi) &= w^{*}_{jk,t+1}(h) + r_{jk,t+1}(h,\pi) \\
&\equiv \Delta^{\alpha}_{jkt}(h) + \Delta^{A}_{jkt}(h) + \Delta^{q}_{jkt}(h) + r_{jk,t+1}(h,\pi)
\end{aligned}
$$

1. $\Delta^{\alpha}_{jkt}(h) \equiv \gamma^{-1}(b_t - 1)^{-1} b_{t+1} \ln \alpha_{jkt}(h)$ is the systematic component of non-pecuniary utility of (j,k)
2. $\Delta^{A}_{jkt}(h) \equiv \gamma^{-1} b_{t+1} \ln \left\{ A_{t+1}\left[H_{jk}(h) \right] \right\}$ is the investment value of (j,k).
3. $\Delta^{q}_{jkt}(h) \equiv \gamma^{-1}(b_t - 1)^{-1} b_{t+1} q_{jk}\left[p_t(h) \right]$ are the idiosyncratic values making executive in fractal $p_{jkt}(h)$ indifferent between (j,k) and retirement.
4. $\Delta^{r}_{jkt}(h)$ is the risk premium defined as:

$$
\Delta^{r}_{jkt}(h) \equiv E\left[r_{jk,t+1}(h,\pi) \right] = \frac{b_{\tau+1}}{\gamma} E\left[\ln\left\{ 1 - \eta g_{jkt}(\pi \mid h) + \eta \left[\frac{\alpha_{jkt}(h)}{\beta_{jkt}(h)} \right]^{1/(b_\tau - 1)} \right\} \right.
$$

with η the unique positive root to:

$$
\int \left\{ \eta^{-1} + \left[\frac{\alpha_{jkt}(h)}{\beta_{jkt}(h)} \right]^{1/(b_t - 1)} - g_{jkt}(\pi \mid h) \right\}^{-1} f_j(\pi)\, d\pi = 1
$$

- Note that (2) is a dynamic discrete choice problem.
- Appealing to Arcidiacono and Miller (2020), $\alpha_{jkt}(h)$ and ρ are identified up the distribution of ε_t.
- Intuitively both are identified off from the different characteristics their job choices, inducing executives to reveal their attitude towards risk, the value they place on nonpecuniary features of the job, and their investment value.
- Assuming ε_t is T1EV, (1) and (3) imply the participation constraint can be expressed as:

$$\begin{aligned} \ln\left(\frac{p_{jkt}(h)}{p_{0t}(h)}\right) &= -\ln\alpha_{jkt}(h) - \frac{b_t - 1}{b_{t+1}} \ln p_{0,t+1}\left[H_{jk}\left(h_t\right)\right] \\ &\quad -(b_t - 1)\ln\Gamma\left[1 + \frac{1}{b_{t+1}}\right] - (b_t - 1)\ln E_t\left[v_{jk,t+1}\right] \end{aligned} \tag{6}$$

- Sample analogs were constructed for the CCPs, compensation schedule, and conditional and unconditional densities of the abnormal return.
- A GMM estimator can be constructed from moment conditions using (6).

Estimates from the Structural Model

Figure 3 from GGM 2015, page 2345

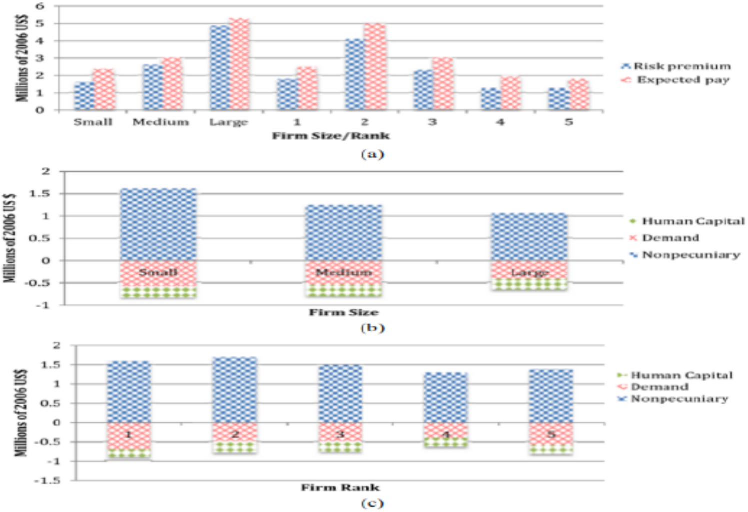

FIGURE 3.—Rank and firm-size pay decomposition. (a) Risk premium, (b) decomposition of certainty-equivalent pay, (c) decomposition of certainty-equivalent pay. *Note*: The certainty equivalent is the sum of human capital, demand, and nonpecuniary compensating differentials.

Estimates from the Structural Model

Figure 4 from GGM 2015, page 2352

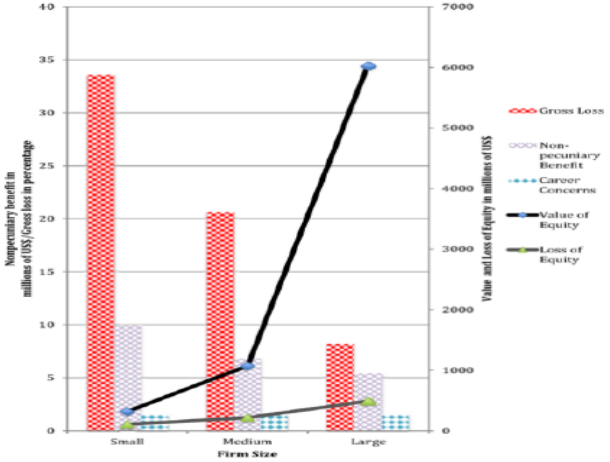

FIGURE 4.—Agency cost decomposition. Sources of agency cost by firm size. *Note*: Gross loss is the percentage of the firm value lost if an executive shirks instead of working. Loss of equity is the firm value lost if an executive shirks instead of working. Nonpecuniary benefit is the value to an executive of shirking relative to working. Career concerns measures the extent to which career concerns ameliorate the agency problem.

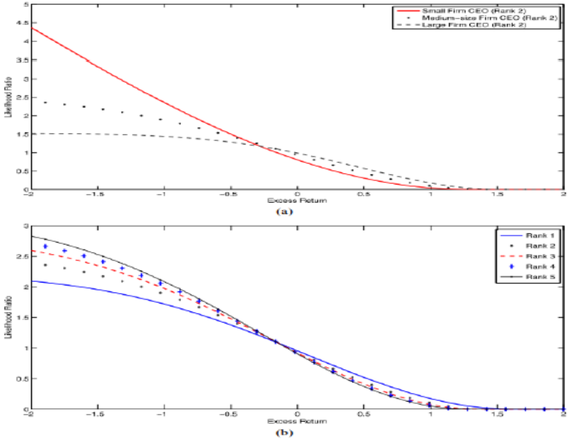

FIGURE 5.—Likelihood ratio. (a)Likelihood ratio by firm size for a CEO, (b) Likelihood ratio by rank 1 for a medium size firm. *Note*: Likelihood ratios are calculated at the average of the sample for the appropriate groups.

Estimates from the Structural Model

Factors explaining the firm-size executive pay premium

1. Large firms employ more talented executives.
2. There is no support for the hypothesis that executives prefer working in small firms. (*They are willing to work in a large firm for less pay.*)
3. There is no firm-size premium for human capital. (*Education and experience gained from different firms are individually significant, but collectively the firm-size pay differentials net out.*)
4. 80% of the firm-size total-compensation gap comes from the risk premium:
   - Signal quality about effort is unambiguously poorer in larger firms, and this fully explains the larger risk premium.
   - Larger firms having more supervisory positions and accountability is more difficult.
5. The remaining 20% comes from demand. Large firms pay a premium to meet demand because their bigger resource base amplifies the marginal productivity of their executives.