Lifecycle Career Concerns

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Structural Econometrics

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Data
## Sources and summary statistics

- Data taken from ExecuComp for the S&P 1500 and COMPUSTAT were matched with data from Who's Who for the years 1992-2006.
- The matching algorithm yielded 16,300 executives (from 30,614) in 2100 firms (from 2818) yielding 59,066 observations.
- Data on executives include: compensation, title, including interlock status, and background, including age, gender, education, annual transitions by title and firm.
- Data on firms include annual return, size (large, medium, small) and sector (primary, service, consumer).
- Summarizing:
  1. The 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.
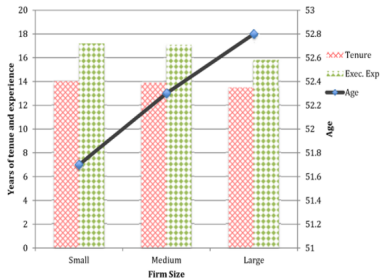 8. Compensation increases with firm size.

Data

Compensation, education and tenure by firm size (Figures 1 and 2, Gayle, Golan and Miller, 2015)

Data
What explains firm-size pay premium in the market for top executives?
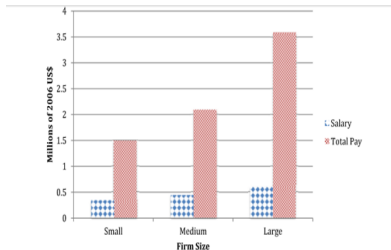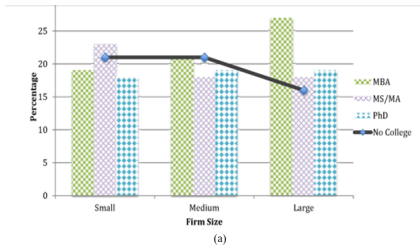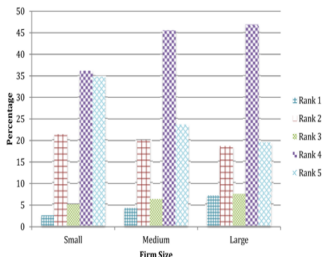
- There are three basic factors that might be playing a role:
  1. Human Capital:
     1. Executives in large firms are older, more educated, but have less executive experience and less tenure than those in smaller firms; presumably human capital of the kind described by Mincer (1974) is playing a role.
     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. Hidden actions require incentives to induce value maximize
  3. Career Concerns: reduce distortions introduced by moral hazard.
     1. The composition of firm denominated securities varies substantially across ranks and executives at different points in their lifecycle.

Model
Job choice and human capital

- Executive chooses job k in firm j, by setting indicator variable $d_{jkt} = 1$, and effort level $l_t \in \{0, 1\}$ where:
  - $j = j_1 \otimes j_2 \in \{0, 1\} \otimes \{1, 2 ..., J_2\}$
  - $j_1 \in \{0, 1\}$ denotes moving to a new firm ($d_{jt}^{(1)} = 1$) or not ($d_{jt}^{(1)} = 0$).
  - $j_2 \in \{1, 2 ..., J_2\}$, denotes firm size and industrial sectors
  - he retires by setting $d_{0t} = 1$ and:
  $$d_{0t} + \sum_{j=1}^{J} \sum_{k=1}^{K} d_{jkt} = 1$$

- Given $d_{jt}^{(1)}$ human capital vector $h_t \equiv (t, h_1, h_{2t})$ follows law of motion:
  $$h_{t+1} \equiv (t + 1, h_1, h_{2,t+1}) \text{ with } h_{2,t+1} = \overline{H}_{jk}(h) \equiv h_{2t} + \Delta_{jt}$$

  where:
  - $h_{2t} \equiv (h_{2t}^{(1)}, h_{2t}^{(2)}, h_{2t}^{(3)})$ and $\Delta_{jt} \equiv (\Delta_{jt}^{(1)}, \Delta_t^{(2)}, \Delta_{jt}^{(3)})$
  - $h_{2t}^{(1)}$ is tenure with current firm and $\Delta_{jt}^{(1)} = 1 + \left(1 - d_{jt}^{(1)}\right) h_{2t}^{(1)}$
  - $h_{2t}^{(2)}$ is years of executive experience and $\Delta_t^{(2)} = h_{2t}^{(2)} + 1$
  - $h_{2t}^{(3)}$ is the number of firms employed as an executive and $\Delta_{jt}^{(1)} = h_{2t}^{(3)} + d_{jt}^{(1)}$

Model
Preferences and budget constraint

- Executives get utility from current consumption c_t.
- Executives have absolute risk aversion parameter ρ.
- Utility depends on h_t where h_1 includes education and gender.
- Jobs, firms, and effort level give nonpecuniary utility through functions $\beta_{jk}(h_t)$ (shirking) and $\alpha_{jk}(h_t)$ (working), where:

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

- An *iid* firm-job privately observed taste shock ε_{jkt} also affects utility.
- Lifetime utility is parameterized as:

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

where we abbreviate by setting $d_{0kt} \equiv d_{0t}$ for all k.
- There are complete markets for all publicly disclosed events, but no borrowing against future executive compensation.

- Firm production is then defined as:

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

where for expositional ease, each executive holds a distinct position and:
  - $t(\tau)$ is the age of executive at calendar time τ
  - $h_t^{(k)}$ denotes the human capital of the executive in position k
  - $F_{jk,t(\tau)}(h_t)$ 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

- Each executive knows his h_t and privately observes realization of ε_{jkt}.
- He selects a firm and position, and submits a compensation proposal, w_{jkt+1}, to shareholders represented by a board.
- If his demand is not approved, the executive retires.
- If the board approves his proposed compensation plan, the executive privately chooses consumption c_t and effort l_t.

Firm and Job Choices
Indexing the value of human capital

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

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

  where:
  - $v_{jk,t+1} = \exp\left(-\rho w_{jk,t+1}/b_{\tau+1}\right)$
  - 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:

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

Firm and Job Choices
Optimization (Theorem 4.2 of Gayle, Golan and Miller 2015)

- 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:

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

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

Cost Minimization
Participation constraint

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

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

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

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

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

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

$$w^A_{jk,t+1}(h) = \frac{b_\tau}{\rho}\left\{\frac{1}{(b_\tau-1)}\ln\alpha_{jkt}(h) + \ln A_{t+1}\left[\overline{H}_{jk}(h)\right] - \frac{1}{(b_\tau-1)}q_{jk}[p_t(h)]\right\}$$

Cost Minimization
Optimal Contract (Theorem 4.3 of Gayle, Golan and Miller 2015)

- The cost minimizing contract, satisfying the incentive compatibility and participation constraints, is:

$$w_{jk,t+1}(h,\pi) \equiv \Delta^{\alpha}_{jkt}(h) + \Delta^{A}_{jkt}(h) + \Delta^{q}_{jkt}(h) + r_{jk,t+1}(h,\pi)$$

1. $\Delta^{\alpha}_{jkt}(h) \equiv \rho^{-1}(b_t-1)^{-1}b_{t+1}\ln\alpha_{jkt}(h)$ is the systematic component of non-pecuniary utility of (j,k)
2. $\Delta^{A}_{jkt}(h) \equiv \rho^{-1}b_{t+1}\ln\left\{A_{t+1}\left[\overline{H}_{jk}(h)\right]\right\}$ is the investment value of (j,k).
3. $\Delta^{q}_{jkt}(h) \equiv \rho^{-1}(b_t-1)^{-1}b_{t+1}q_{jk}[p_t(h)]$ 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:

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

with η the unique positive root to:

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

Extending the Model to Incorporate Career Concerns

Asymmetric information about human capital

- We now assume that the benefits from accumulating human capital are private information.
- In particular suppose that human capital accumulation depends on effort:

$$h_{t+1} \equiv \sum_{j=1}^{J} \sum_{k=1}^{K} d_{jkt} \left[l_t \overline{H}_{jk}(h_t) + (1 - l_t) \underline{H}_{jk}(h_t) \right]$$

where $\underline{H}_{jk}(h_{1t}, h_{2t}) = h_{2t} + \underline{\Delta}_{jk}$ and:

- $\underline{\Delta}_{jk} \equiv \left(\underline{\Delta}_{jk}^{(1)}, \underline{\Delta}_{jk}^{(2)}, \underline{\Delta}_{jk}^{(3)} \right)$.
- $\underline{\Delta}_{jk}^{(1)} = -h_{2t}^{(1)}$ meaning the executive would lose all his firm-specific capital.
- $\underline{\Delta}_{jk}^{(2)} = 0$ meaning he does not increase his executive working experience.
- $\underline{\Delta}_{jk}^{(3)} = 0$, meaning changing firms does not increase the number of firms he has worked in.

Extending the Model to Incorporate Career Concerns

Indexing the value of human capital in the extended model of career concerns

- The valuation function replacing $A_{t+1}(h)$ depends now on actual human capital h and shareholder beliefs h':

$$
\begin{aligned}
B_t\left(h, h'\right) \;=\;\; & p_{0t}\left(h, h'\right) E_t\left[\exp\left(\frac{-\varepsilon^*_{0t}}{b_{\tau(t)}}\right)\right] \\
& + \sum_{j=1}^{J} \sum_{k=1}^{K} \left\{ p_{jkt}\left(h, h'\right) E_t\left[\exp\left(\frac{-\varepsilon^*_{jkt}}{b_{\tau(t)}}\right)\right] V'_{jkt}(h, h') \right\}
\end{aligned}
$$

- If ε_{jkt} is distributed T1EV then:

$$
B_t\left(h, h'\right) = \Gamma\left(\frac{b_\tau + 1}{b_\tau}\right) p_{0t}\left(h, h'\right)^{\frac{1}{b_t}}
$$

- Note $B_t\left(h, h'\right)$ has the same form as $A_t(h)$, except it depends on $p_{0t}\left(h, h'\right)$ instead of $p_{0t}(h)$ to reflect the role of the executives' reputation versus their actual human capital.

Extending the Model to Incorporate Career Concerns

Incentive compatibility constraint

- In the basic model effort only affects current expected payoff, so the incentive compatibility constraint is:

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

whereas in the extended model, it is:

$$\left[\frac{\alpha_{jkt} (h)}{\beta_{jkt} (h)} \right]^{1/(b_\tau-1)} \leq \frac{E_t \left[v_{jk,t+1} g_{jkt} (\pi \mid h) \right] B_{t+1} \left[\underline{H}_{jk} (h), \overline{H}_{jk} (h) \right]}{E_t \left[v_{jk,t+1} \right] B_{t+1} \left[\overline{H}_{jk} (h), \overline{H}_{jk} (h) \right]} \quad (5)$$

- Whenever $B_{t+1} \left[\overline{H}_{jk} (h), \overline{H}_{jk} (h) \right] < B_{t+1} \left[\underline{H}_{jk} (h), \overline{H}_{jk} (h) \right]$, career concerns ameliorate the agency problem.
- For example, the future benefits of human capital fully offset the current gains from shirking, implying the executive would work for a fixed wage satisfying the participation constraint, if:

$$\left[\frac{\alpha_{jkt} (h)}{\beta_{jkt} (h)} \right]^{1/(b_\tau-1)} \leq \frac{B_{t+1} \left[\underline{H}_{jk} (h), \overline{H}_{jk} (h) \right]}{B_{t+1} \left[\overline{H}_{jk} (h), \overline{H}_{jk} (h) \right]}$$

Equilibrium
Market clearing and perfect equilibrium

- Free entry by firms implies:

$$F_{jkt}(h) = \left\{ \begin{array}{l} E\left[w_{jk,t+1}^A(h) + r_{jk,t+1}^A(h,\pi)\right] \text{ in the basic model} \\ E\left[w_{jk,t+1}^B(h) + r_{jk,t+1}^B(h,\pi)\right] \text{ in the extended model} \end{array} \right.$$

  where $w_{jk,t+1}^B(h)$ and $r_{jk,t+1}^B(h,\pi)$ are defined analogously to $w_{jk,t+1}^A(h)$ and $r_{jk,t+1}^A(h,\pi)$.

- This entry condition essentially completes the equilibrium in the basic model.

- In the extended model:
  - there is only one subgame, the whole game.
  - we assume executives who shirk become tainted, lowering their productivity to levels that are unacceptable to shareholders.
  - a perfect equilibrium exists where all executives work on the equilibrium path, and it is not optimal for executives to declare any past shirking.

Identification and Estimation
Compensating differentials and risk aversion

- Note that (2) is a dynamic discrete choice problem.
- Appealing to Arcidiacono and Miller (2015), $\alpha_{jkt}(h)$ 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:

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

- 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).

Identification and Estimation
Agency issues

- This only leaves $\beta_{jkt}(h)$ and $g_{jkt}(\pi|h)$ to identify in the basic model.
- Both are identified off the curvature of the compensation equation.
- Here we follow the estimator of Gayle and Miller (2015) by exploiting the incentive compatibility condition.
- The extended model, and $\underline{H}_{jk}(h)$ in particular, is not identified without strong functional form assumptions.
- To see this, define:

$$\beta^*_{jkt}(h) = \beta_{jkt}(h) \left\{ \frac{B_{t+1}\left[\underline{H}_{jk}(h), \overline{H}_{jk}(h)\right]}{E_t\left[v_{jk,t+1}\right] B_{t+1}\left[\overline{H}_{jk}(h), \overline{H}_{jk}(h)\right]} \right\}^{1-b_\tau}$$

and note that $\beta_{jkt}(h)$ satisfies (4) the incentive compatibility constraint with equality for the basic model if and only if $\beta^*_{jkt}(h)$ satisfies (5) the incentive compatibility constraint with equality for the extended model.
- This remark provides the basis for establishing that every extended model is observationally equivalent to a basic model.

Estimates from the Structural Model
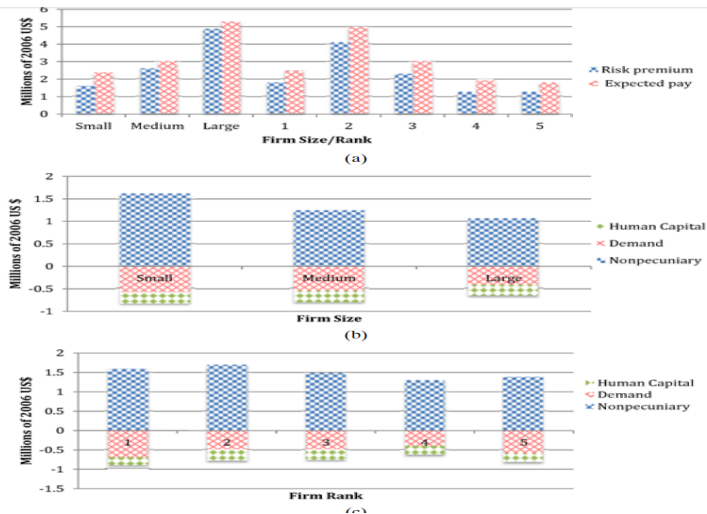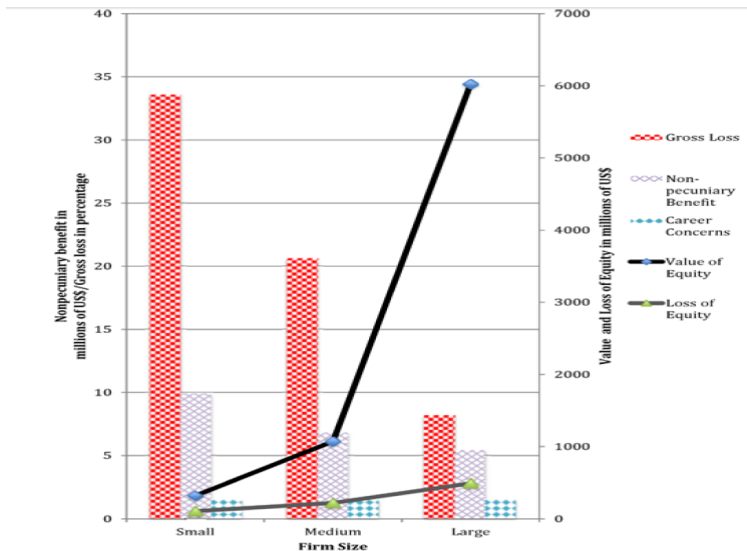
Figure 3 from Gayle, Golan and Miller (2015)

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.
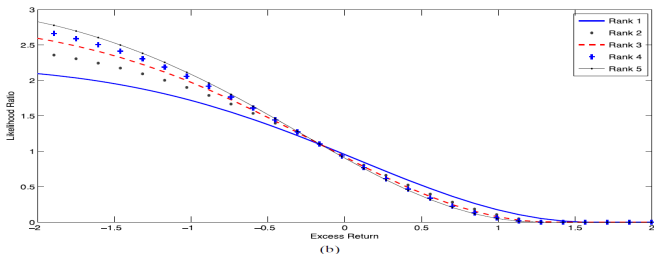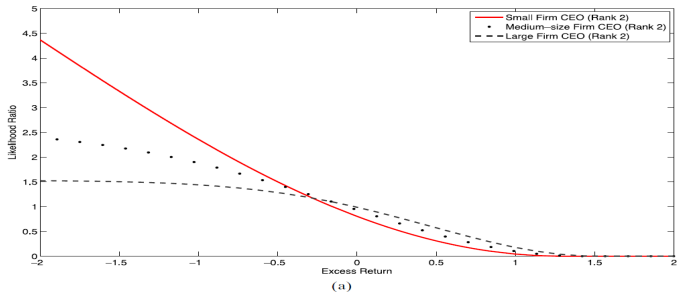
Figure 4 from Gayle, Golan and Miller (2015)

Figure 5 from Gayle, Golan and Miller (2015)

(a)

(b)

Estimates from the Structural Model
Three factors explain 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. The opposite is true.
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 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 firm also pays a premium to meet net demand because a greater resource base amplifies marginal productivity of executives.