Lecture 5: The Risk-Incentive Trade-Off

Compensation in Organizations

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Recalling Performance Pay Results

Theorem 1

When wages depend only on output, effort is e_p which solves

$$c'(e_p) = \frac{1}{1 + r\sigma^2 c''(e_p)}$$

and $\beta_p = c'(e_p), \alpha_p = \bar{u} - \beta_p e_p + r\beta^2\sigma^2/2 + c(e_p)$.

- ▶ Focus on: $c'(e_p) = \frac{1}{1+r\sigma^2 c''(e_p)}$

- ▶ As σ^2 rises, β_p falls

- ▶ Incentives/performance pay/bonuses decrease with noise/luck/randomness.

- ▶ This is the risk-incentive trade-off.

- ▶ e_p also generally falls, although this is harder to prove.

Discussion: Drago and Garvey (1998)

Trade-Off is (in some sense) Theoretically Robust

▶ The model we solved is a very special type of principal-agent model.

▶ We could allow for nonlinear wages, general output, etc.

▶ However, even when we do this, we still find that risk aversion reduces incentives and effort.

Profit

- The level of effort is tied to total surplus/efficiency.

- As effort rises and goes to e^*, total surplus/efficiency rises.

- Therefore, since e_p falls with σ^2, profit should fall.

- To see this very clearly, let's derive profit when $c(e) = e^2/2$.

- Remember: $e_p = \beta_p = \frac{1}{1+r\sigma^2}$ in this case!

Profit Under Performance Pay and $c(e) = e^2/2$

$$\pi_p = e_p - c(e_p) - \frac{r\beta_p^2\sigma^2}{2} - \bar{u}$$

$$= \frac{1}{1 + r\sigma^2} - \frac{1}{2(1 + r\sigma^2)} - r\sigma^2\frac{1}{2(1 + r\sigma^2)} - \bar{u}$$

$$= \frac{1}{1 + r\sigma^2}\left(1 - \frac{1}{2(1 + r\sigma^2)} - r\sigma^2\frac{1}{2(1 + r\sigma^2)} - \bar{u}\right.$$

$$= \frac{1}{1 + r\sigma^2}\left(1 - \frac{1 + r\sigma^2}{2(1 + r\sigma^2)}\right) - \bar{u}$$

$$= \frac{1}{1 + r\sigma^2}\left(\frac{2(1 + r\sigma^2)}{2(1 + r\sigma^2)} - \frac{1 + r\sigma^2}{2(1 + r\sigma^2)}\right) - \bar{u}$$

$$= \frac{1}{1 + r\sigma^2}\left(\frac{1 + r\sigma^2}{2(1 + r\sigma^2)}\right) - \bar{u}$$

$$= \frac{1}{2}\frac{1}{1 + r\sigma^2} - \bar{u}$$

Performance Pay vs. Some Alternative Method

▶ Suppose the firm can use performance pay or some alternative with profit π_{alt}.

▶ It will choose performance paif if:

$$\pi_p = \frac{1}{2}\frac{1}{1 + r\sigma^2} - \bar{u} \geq \pi_{alt}$$

▶ As σ^2 rises, performance pay becomes less likely.

▶ This is a testable implication of the risk-incentive trade-off.

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Discussion: Gaynor and Gertler (1995)

"Moral hazard and risk spreading in partnerships" (Gaynor and Gertler 1995)

▶ Setting is medical group practices.

▶ At time of article, 61% of physicians worked in group settings.

▶ In these groups, physicians are co-owners making decisions together, including fees and resource allocations.

▶ Physicians have specialties but demand can be highly variable across specialties (exmaple?)

▶ Data shows how much compensation depends on output (1-10), size of group, price of an office visit, and a measure of physician risk aversion.

"Moral hazard and risk spreading in partnerships" (Gaynor and Gertler 1995)

▶ Concern: self-reported measure of risk aversion may just reflect what physician experiences rather than what they "want."

▶ Alleviated: risk aversion measure is negatively correlated with performance pay measure.

▶ 10% increase in incentives leads to 3.5% more visits.

▶ Price decreases demand (why is this a good sign?)

"Moral hazard and risk spreading in partnerships" (Gaynor and Gertler 1995)

- ▶ Varying risk aversion variable across full range alters ofice visits by over 877 per year.

- ▶ The most risk averse physicians make about $11,582 less than the least risk averse.

- ▶ This is 10% of mean income.

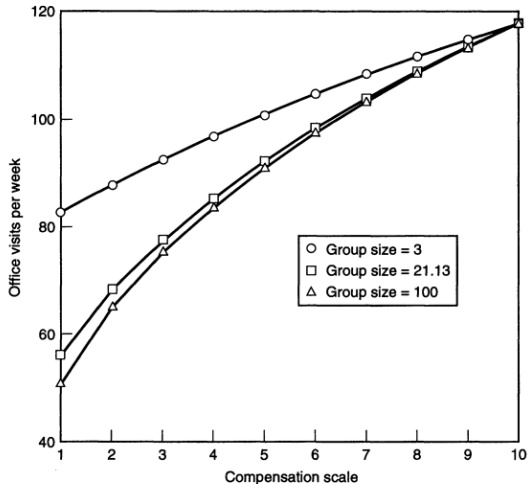- ▶ It is a measure of the efficiency loss of partnerships.

"Moral hazard and risk spreading in partnerships" (Gaynor and Gertler 1995)

TABLE 2   **Instrumental Variable Estimates of the Individual Physician-Demand Function (7a). Dependent Variable: ln(office visits).**

	Least Squares	Random Effects
Independent variables		
Constant	5.24***	5.05***
	(11.65)	(8.32)
Ln(incentive variable)[a]	.41***	.38***
	(5.35)	(4.29)
Ln(hours of nonphysician personnel)	.12***	.16**
	(3.27)	(2.36)
Ln(price)[a]	−.47***	−.49**
	(−2.71)	(−2.36)
Examining rooms	−.00006	.0000015
	(−.0003)	(.35)
Experience	.04***	.035***
	(6.61)	(6.17)
Experience, squared	−.001***	−.001***
	(7.63)	(−7.36)
Foreign medical graduate	−.18***	−.15**
	(2.85)	(−2.09)
Subspecialty	−.14***	−.14***
	(−3.32)	(−3.33)
Pediatrics	.10**	.12*
	(1.95)	(1.96)

"Moral hazard and risk spreading in partnerships" (Gaynor and Gertler 1995)

INCENTIVES AND PHYSICIAN PRODUCTIVITY: SMALL, MEDIUM, AND LARGE GROUPS

Note: Evaluated at mean values.

"Moral hazard and risk spreading in partnerships" (Gaynor and Gertler 1995)

TABLE 5 Tradeoff Between Moral Hazard and Risk Spreading
Estimates of the Effect on an Increase in the Importance of Regularity of Income[a]

Source of Effect[b]	Annual Change	Office Visits Percent Change	Value[c,d]	Percent of Annual Income[c,d,e]
Incentive variable	−1,232.3	−28.4%	−$16,266.36	−14.5%
Compensation scale	−1,237	−28.5%	−$16,328	−14.6%
Group size	+5.61	+.13%	+$74.05	+.066%
Nonphysician inputs	+95.1	+2.04%	+$1,255	+1.12%
Total	−877.4	−20.36%	−$11,582	−10.38%

[a] Effect of change in importance of regularity of income from 1 to 4.
[b] Evaluated at the means.
[c] Calculated based on a 50-week year.
[d] Calculated based on a mean price of $13.20 per office visit in the data.
[e] Calculated based on a mean annual gross income for physicians of $111,900 in 1978 (Glandon and Shapiro, 1980).

"Is a Higher Calling Enough? Incentive Compensation in the Church" (Hartzell, Parsons, Yermack 2010)

- ▶ Recall the setting: Methodist ministers whoa re rotated but have their pay set by their congregation.

- ▶ The paper shows evidence that Methodist ministers pay is consistent with pay for performance.

- ▶ Ministers get more pay for adding more people to their church.

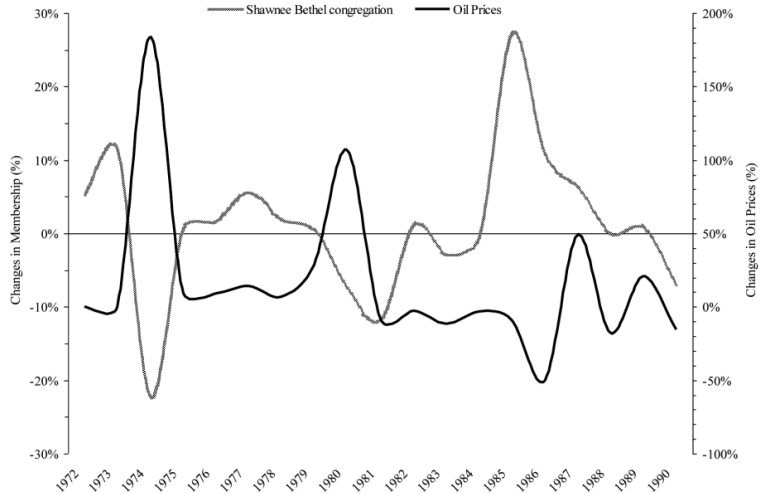- ▶ Let's focus on the portions related to the risk-incentive trade-off.

"Is a Higher Calling Enough? Incentive Compensation in the Church" (Hartzell, Parsons, Yermack 2010)

- ▶ The paper actually tests the risk-incentive trade-off two ways:
  - ▶ By estimating how volatile each church location's membership is over 43 years.

  - ▶ By comparing oil-driven locations vs. non-oil drivne locations

- ▶ Both methods have problems (they are not the core result of the paper).

- ▶ But both point towards the existence of the risk-incentive trade-off.

Hartzell, Parsons, Yermack 2010: Direct Computation of Volatility

▶ Idea: use the entire time series of 43 years to compute the standard deviation of membership changes.

▶ In our performance pay model, this is a proxy for σ^2 if we assume that effort does not change much over time.

▶ The authors classify a church as "High Volatility" if the church's standard deviation is above the median.

▶ "High Volatility" churches pay on average \$10.75 less per new member than the rest.

▶ This is 50% less "bonus" (β)

▶ One issue: perhaps at volatile churches the value of a member is just less (the coefficient on e is smaller) so they use lower incentives.

Hartzell, Parsons, Yermack 2010: Oil Booms

Hartzell, Parsons, Yermack 2010: Oil Booms

- ▶ Idea: use oil booms as proxy for volatility.

- ▶ This is "better" because oil booms are an exogenous or external factor impacting attendance.

- ▶ Boom and bust clearly bring people in and out (direct cyclical effect).

- ▶ But also, as a town gets richer from oil, attendance may also drop.

Hartzell, Parsons, Yermack 2010: Results

Table 7
Pay-Performance Sensitivity and Risk Factors

Dependent Variable	Δ(Total Comp.)	Δ(Total Comp.)	Δ(Total Comp.)
Δ(Members$_{t-1}$)	$22.63*** (4.61)	$18.48*** (3.16)	$23.44*** (4.57)
Δ(Members$_{t-1}$) × High Volatility	−$10.75*** (4.16)		−$8.45** (3.92)
Δ(Members$_{t-1}$) × Oil Driven		−$8.06** (3.57)	−$5.67* (3.36)
Δ(Members$_{t-1}$) × Average Membership × 10^{-3}	−3.29** (1.36)	−1.90** (.93)	−3.09*** (1.18)
Observations	15,760	15,758	15,758
R^2	.062	.062	.063
Year fixed effects	Yes	Yes	Yes
Number of church clusters	698	696	696

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"The Tenous Trade-off Between Risk and Incentives" (Prendergast 2002)

TABLE 1
THE TRADE-OFF OF RISK AND INCENTIVES FOR EXECUTIVES

Authors	Measure of Risk	Result
Lambert and Larcker (1987)	Volatility of returns	−
Garen (1994)	Volatility of returns	0
Yermack (1995) (options only)	Variance of returns	0
Bushman et al. (1996)	Volatility of returns	0
Ittner et al. (1997) (full sample)	Correlation of financial and accounting returns	0
Aggarwal and Samwick (1999)	Volatility of returns	−
Core and Guay (1999)	Idiosyncratic risk	+
Conyon and Murphy (1999)	Volatility of returns	0
Jin (2000)	Idiosyncratic risk	−
Core and Guay (in press)	Volatility of returns	+
Oyer and Shaefer (2001)	Options grants	+

"The Tenous Trade-off Between Risk and Incentives" (Prendergast 2002)

The amount sharecroppers keep (β) is positively associated with noise (σ^2).

TABLE 2

THE TRADE-OFF OF RISK AND INCENTIVES FOR SHARECROPPERS

Authors	Measure of Risk	Result
Rao (1971)	Variance of profits	+
Allen and Lueck (1992)	Coefficient of variation in yield	+
Allen and Lueck (1995)	Coefficient of variation in yield (within crop)	+

"Incentive Contracting and the Franchise Design." (Lafontaine and Slade (2001))

TABLE 3
RISK AND THE DECISION TO FRANCHISE

Authors	Industry	Result
Martin (1988)	Panel across sectors	+
Norton (1988)	Restaurants and hotels	+
Lafontaine (1992)	Many sectors (business format franchising)	+
Anderson and Schmittlein (1984)	Electronics components	0
John and Weitz (1988)	Industrial firms	0

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Choosing What to Do

▶ Our model assumes the worker only chooses *e*.

▶ But what if the worker also chooses what to exert effort on.

▶ For this discussion assume the firm can measure effort.

▶ What if also the worker knows the benefit of each activity, but the firm does not?

Supporting source: "The Tenous Trade-off Between Risk and Incentives" (Prendergast 2002)

Choosing What to Do

- ▶ The firm has two choices: (1) choose what the agent can do and specify an effort based wage (2) let the agent choose and specify an output based wage.

- ▶ We can get the right effort from (1), but the firm might choose the wrong activity.

- ▶ We will get the wrong effort from (2) but the worker will choose the right activity (why?)

- ▶ The key observation is that the maximum of random variables generally depends on variance.

Supporting source: "The Tenous Trade-off Between Risk and Incentives" (Prendergast 2002)

Choosing What to Do

▶ For two normal random variables with mean 0 and variance σ^2 we have:

$$E[\max\{\epsilon_1, \epsilon_2\}] = \frac{\sigma}{\pi}$$

▶ So "delegation" using performance pay $w(y)$ (option 2) becomes better relative to effort-based pay and command and control (option 1) when variance is larger.

▶ This overturns our earlier result and suggests a positive relationship between risks and performance pay!

▶ CEOs, franchising, etc. requires making complex decisions with situation-specific knowledge.

Supporting source: "The Tenuous Trade-off Between Risk and Incentives" (Prendergast 2002)

Favoritism in Performance Evaluations

▶ It is typically supervisors, not firms, that measure output via performance evaluations.

▶ But it is is costly for supervisors to give employees they like bad performance evaluations.

▶ And the cost grows when more is on the line: that is when β is higher!

▶ Therefore stronger incentives (higher β) makes supervisors less truthful about employee performance.

▶ Example: If you and I are good friends at work, I want you to make more money.

Source "Uncertainty and Incentives" (Prendergast 2002)

Favoritism in Performance Evaluations

▶ But suppose a firm (not the supervisor) uses performance evaluations for two things:

1. To encourage effort (as in our model).

2. To allocate the worker to the right job (not in our model).

Favoritism in Performance Evaluations

▶ How does favoritism impact goal 1 (encouraging effort)?

▶ Suppose a supervisor's favoritism for a person is given by K that just adds to their reported output: $\tilde{y} = K + y = K + e + \epsilon$.

▶ When $K > 0$ there is biased towards the person, when $K < 0$ they are biased against the person.

▶ The supervisor and the worker know K exactly.

▶ From the firm's perspective the supervisor's favoritism for a person is given by a random variable K that just adds to their reported output: $\tilde{y} = K + y = K + e + \epsilon$.

▶ Suppose on average favoritism is unbiased ($E[K] = 0$) and independent of everything else.

Favoritism in Performance Evaluations

▶ Then for fixed effort and wages, the worker will receive:

$$w(\tilde{y}) = \alpha + \beta\tilde{y} = \alpha + \beta(K + e + \epsilon)$$

▶ From the perspective of the worker, favoritism is known and just shifts utility by a constant:

$$E[w(\tilde{y})] = E[\alpha + \beta(K + e)] + E[\beta\epsilon] = \alpha + \beta e = \beta K$$

$$Var(w(\tilde{y})) = Var(\alpha + \beta(K + e)) + Var(\beta\epsilon) = 0 + \beta^2\sigma^2$$

▶ From the perspective of the firm, profit is:

$$\pi = E[y - w(\tilde{y})] = E[e + \epsilon - \alpha - \beta(K + e + \epsilon)] = e - \beta e - \alpha$$

where K has dropped out entirely because the firm is risk neutral.

▶ Therefore the firm can easily account for favoritism in the wage.

Favoritism in Performance Evaluations

▶ But when performance evaluations are used for goal 2 (allocation) there are big problems.

▶ When a supervisor reports a biased evaluation $\tilde{y} \neq y$, the firm cares about whether bias is positive or negative.

▶ Otherwise they may accidentally assign the worker to a task they are actually bad at doing!

▶ As β rises, $\tilde{y}$ becomes more biased.

▶ Then $\tilde{y}$ becomes less useful for allocating talent.

▶ This is a new tension between encouraging effort and allocating people, and it is real (e.g. talent hoarding).

Favoritism in Performance Evaluations

▶ How does this impact the risk/incentive trade-off?

Favoritism in Performance Evaluations

- ▶ How does this impact the risk/incentive trade-off?

- ▶ In this context, we can think of σ^2 as measuring how much output reflects true talent.

- ▶ The higher σ^2, the less output tells us about talent.

- ▶ But if σ^2 is high, even if there is no bias ($\tilde{y} = y$) performance evaluations are useless for allocating talent!

- ▶ Therefore goal 2 does not matter, and we have a potential positive correlation between risk and incentives!

Deciding When to Investigate

▶ In our model, we assumed output is always known.

▶ In reality, output is only sometimes monitored.

▶ Further, it is monitored more often when people suspect slacking/shirking/cheating.

▶ Consider a model where a supervisors chooses whether to launch an investigation.

▶ If no investigation, the worker gets a wage equal to expected output (so a flat salary)

▶ If investigated, they get actual output.

Source "Uncertainty and Incentives" (Prendergast 2002)

Deciding When to Investigate

- ▶ When deciding to investigate, the supervisor gets a signal or impression of output.

- ▶ There is some cost to investigation (laying it out here is beyond the scope of this class)

- ▶ The supervisor investigates if the expected benefit of doing so is great enough.

- ▶ In this setting, greater performance pay (β) is needed to encourage effort when noise is greater, because we also need to encourage investigations.

- ▶ Intuitively, noise makes workers think they can get away with it.

- ▶ this also generates a positive link between risk and incentives.

Source "Uncertainty and Incentives" (Prendergast 2002)