

# Lecture 5: The Risk-Incentive Trade-Off

Compensation in Organizations

Jacob Kohlhepp

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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  $\sigma^2$  rises,  $\beta_p$  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  $\sigma^2$ , 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 $c(e) = e^2/2$

$$\begin{aligned}\pi_p &= e_p - c(e_p) - \frac{r\beta_p^2\sigma^2}{2} - \bar{u} \\&= \frac{1}{1+r\sigma^2} - \frac{1}{2(1+r\sigma^2)} - r\sigma^2 \frac{1}{2(1+r\sigma^2)} - \bar{u} \\&= \frac{1}{1+r\sigma^2} \left( 1 - \frac{1}{2(1+r\sigma^2)} - r\sigma^2 \frac{1}{2(1+r\sigma^2)} \right) - \bar{u} \\&= \frac{1}{1+r\sigma^2} \left( 1 - \frac{1+r\sigma^2}{2(1+r\sigma^2)} \right) - \bar{u} \\&= \frac{1}{1+r\sigma^2} \left( \frac{2(1+r\sigma^2)}{2(1+r\sigma^2)} - \frac{1+r\sigma^2}{2(1+r\sigma^2)} \right) - \bar{u} \\&= \frac{1}{1+r\sigma^2} \left( \frac{1+r\sigma^2}{2(1+r\sigma^2)} \right) - \bar{u} \\&= \frac{1}{2} \frac{1}{1+r\sigma^2} - \bar{u}\end{aligned}$$

## Performance Pay vs. Some Alternative Method

- ▶ Suppose the firm can use performance pay or some alternative with profit  $\pi_{alt}$ .
- ▶ It will choose performance pay if:

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

- ▶ As  $\sigma^2$  rises, performance pay becomes less likely.
- ▶ This is a testable implication of the risk-incentive trade-off.

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Evidence for the Risk-Incentive Trade-Off

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(Potential) Resolutions of the Controversy



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 office 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.

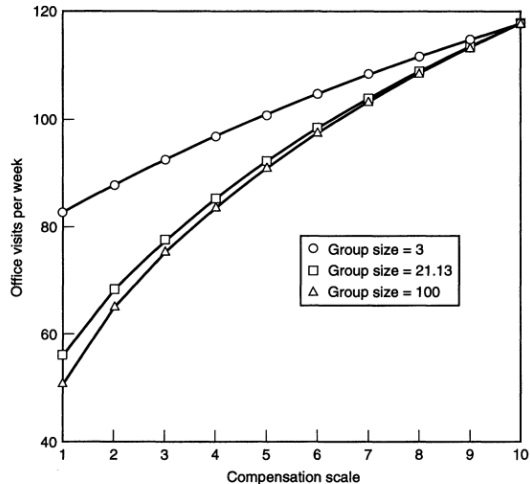
# “Moral hazard and risk spreading in partnerships” (Gaynor and Gertler 1995)

**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*** (11.65)	5.05*** (8.32)
Ln(incentive variable) <sup>a</sup>	.41*** (5.35)	.38*** (4.29)
Ln(hours of nonphysician personnel)	.12*** (3.27)	.16** (2.36)
Ln(price) <sup>a</sup>	-.47*** (-2.71)	-.49** (-2.36)
Examining rooms	-.00006 (-.0003)	.0000015 (.35)
Experience	.04*** (6.61)	.035*** (6.17)
Experience, squared	-.001*** (7.63)	-.001*** (-7.36)
Foreign medical graduate	-.18*** (2.85)	-.15** (-2.09)
Subspecialty	-.14*** (-3.32)	-.14*** (-3.33)
Pediatrics	.10** (1.95)	.12* (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<sup>a</sup>**

Source of Effect <sup>b</sup>	Annual Change	Office Visits Percent Change	Value <sup>c,d</sup>	Percent of Annual Income <sup>c,d,e</sup>
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%

<sup>a</sup> Effect of change in importance of regularity of income from 1 to 4.

<sup>b</sup> Evaluated at the means.

<sup>c</sup> Calculated based on a 50-week year.

<sup>d</sup> Calculated based on a mean price of \$13.20 per office visit in the data.

<sup>e</sup> 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 who are 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.



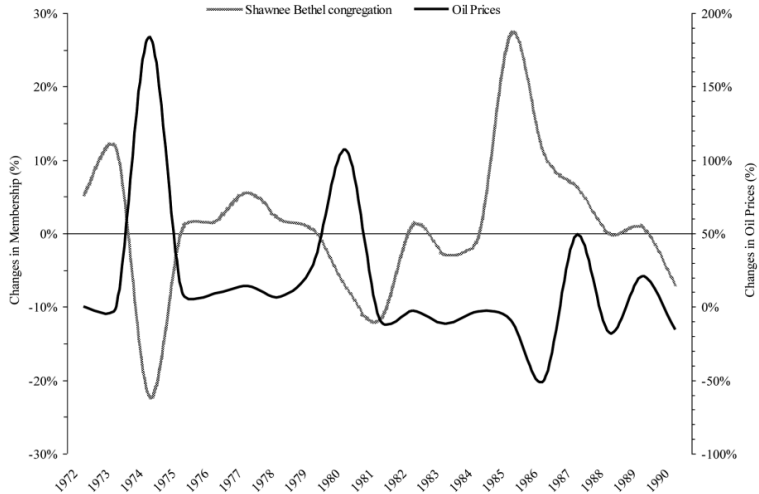
## “Is a Higher Calling Enough? Incentive Compensation in the Church” (Hartzell, Parsons, Yermack 2010)

- ▶ 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 driven 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  $\sigma^2$  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” ( $\beta$ )
- ▶ 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	$\Delta(\text{Total Comp.})$	$\Delta(\text{Total Comp.})$	$\Delta(\text{Total Comp.})$
$\Delta(\text{Members}_{t-1})$	\$22.63*** (4.61)	\$18.48*** (3.16)	\$23.44*** (4.57)
$\Delta(\text{Members}_{t-1}) \times \text{High Volatility}$	-\$10.75*** (4.16)		-\$8.45** (3.92)
$\Delta(\text{Members}_{t-1}) \times \text{Oil Driven}$		-\$8.06** (3.57)	-\$5.67* (3.36)
$\Delta(\text{Members}_{t-1}) \times \text{Average Membership} \times 10^{-3}$	-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 ( $\beta$ ) is positively associated with noise ( $\sigma^2$ ).

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  $\sigma^2$  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 costly for supervisors to give employees they like bad performance evaluations.
- ▶ And the cost grows when more is on the line: that is when  $\beta$  is higher!
- ▶ Therefore stronger incentives (higher  $\beta$ ) 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  $\beta$  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  $\sigma^2$  as measuring how much output reflects true talent.
- ▶ The higher  $\sigma^2$ , the less output tells us about talent.
- ▶ But if  $\sigma^2$  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 ( $\beta$ ) 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)