Why Do Bigger Firms Pay More For Performance?

Performance-based versus Market-based Incentives

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Introduction

Executive Labor Market and Contract Incentives

- No. 1 compensation philosophy for named executive officers in Amazon

  "to attract and retain the highest caliber employees by providing above industry-average compensation ..."

- Apple Inc.'s 2016 proxy statement

  "experienced personnel in the technology industry are in high demand, and competition for executive talent is intense ... "

  Their executives contract incentives are designed

  " to attract and retain a talented executive team and align executives interests with those of shareholders ..."

Motivating Facts

- A typical executive compensation package:

  ```
  fixed salary  +  performance-based pays
                   (bonus, stocks, options, etc.)
      30%                 70%
  ```

- Performance-based incentives

$$\texttt{delta} = \frac{\Delta \texttt{Wealth(in dollars)}}{\Delta \texttt{Firm Value(in percentage)}}$$

- Fim size premium in performance-based incentives

  delta increases in firm size,

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- Fim size premium in performance-based incentives

  delta increases in firm size, controling for total
  compensations

Motivating Fact: Size Premium

Data (all groups)
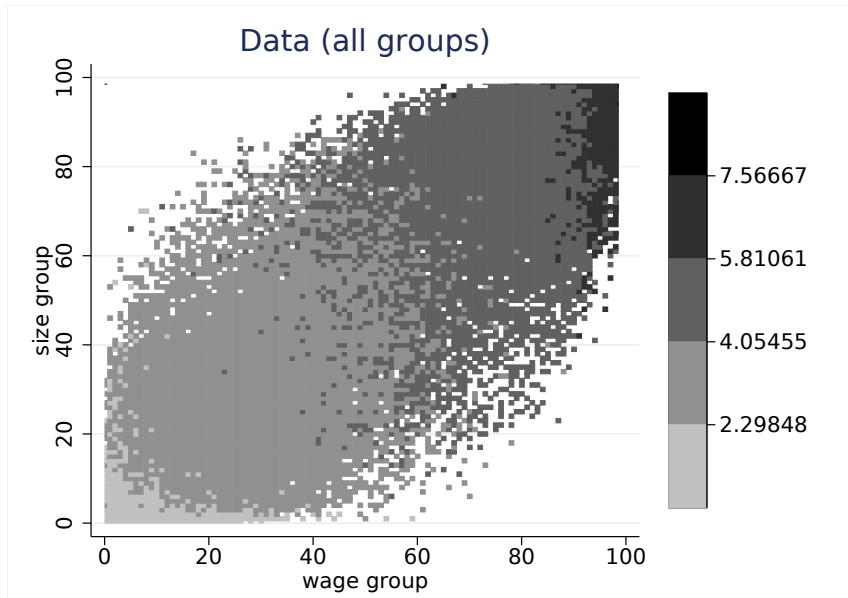
Motivating Fact: Size Premium

Table 1: Incentive Pays Increase with Firm Size

	$\log(delta)$			
	(1)	(2)	(3)	(4)
log(Firm Size)	0.578***	0.295***	0.274***	0.273***
	(250.03)	(112.20)	(104.10)	(103.68)
log(tdc1)		0.7159***		
		(176.18)		
tdc1 Dummies (50)			Yes	
tdc1 Dummies (100)				Yes
Year FEs	Yes	Yes	Yes	Yes
Industry FEs	Yes	Yes	Yes	Yes
Year × Industry FEs	Yes	Yes	Yes	Yes
Observations	129458	129184	129185	129185

Motivating Fact: Size Premium and Labor Market

Table 2: Market Forces and Market Incentives

	$\log(delta)$			
	(1)	(2)	(3)	(4)
log(Firm Size)	0.340***	0.372***	0.254***	0.247***
	(35.18)	(68.97)	(23.82)	(17.45)
log(Firm Size) × External CEO	0.121***			
	(4.27)			
Firm_Number		0.000331***		
		(3.67)		
log(Firm Size) × Firm_Number		.0000151		
		(2.55)		
Size-Dist-CV			-2.652***	
			(-14.01)	
log(Firm Size) × Size-Dist-CV			0.220***	
			(10.23)	
Size-Dist-Gini				-5.743***
				(-11.60)
log(Firm Size) × Size-Dist-Gini				0.462***
				(8.11)
log(tdc1)	0.589***	0.589***	0.652***	0.651***
	(106.98)	(106.91)	(146.40)	(146.23)
age	-0.116***	-0.116***	-0.119***	-0.119***
	(-28.35)	(-28.31)	(-33.38)	(-33.36)
age^2	0.00149***	0.00149***	0.00151***	0.00151***
	(28.99)	(28.96)	(45.50)	(45.48)

Summary

Motivating Facts:

- Size premium exists *controlling for total compensations*.
- Size premium is larger in industries where the executive labor market is more active.
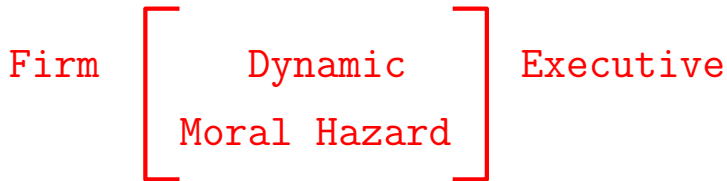
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Research Question:
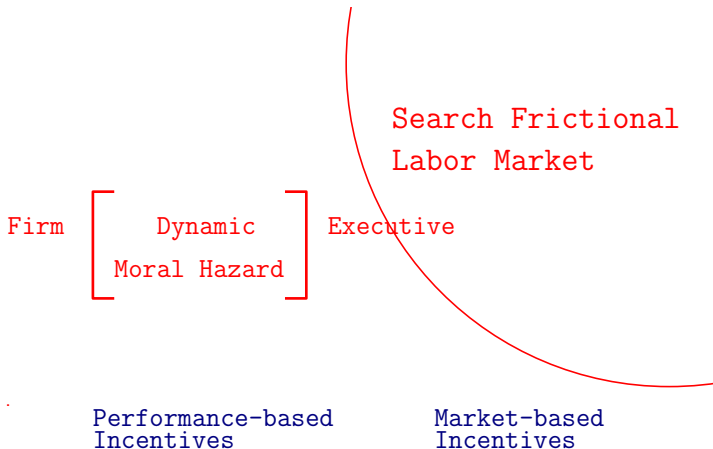
- Why do larger firms pay more for performance?

What do I do?

1. Builds a model that links the labor market and contract incentives

   - market competition for executives generates market-based incentives
   - explains the *firm size premium in contract incentives*

2. Estimates the model to US Executives Data (ExecuComp)

3. Evaluates suggested policy regulations on executive compensation

Key Elements in the Model

$$\text{Firm} \begin{bmatrix} \text{Dynamic} \\ \text{Moral Hazard} \end{bmatrix} \text{Executive}$$

Key Elements in the Model

Search Frictional
Labor Market

Firm $\begin{bmatrix} \text{Dynamic} \\ \text{Moral Hazard} \end{bmatrix}$ Executive

Performance-based
Incentives

Market-based
Incentives

Key Elements in the Model

Market-based Incentives

- taking effort today improves managerial skills
- higher managerial skills leads to higher market values

Market-based Incentives is lower in larger firms

- firm size is a 'search capital', larger firm executives have higher expected value increase
- by diminishing marginal utility, market-based incentives are smaller for them

Related Literature

- Assignment Models
  - Edmans, Gabaix and Landier (2009), Edmans and Gabaix (2011)
  - executives in larger firms value leisure more $u(w \times g(e))$.
- Moral Hazard Models
  - Margiotta and Miller (2000), Gayle and Miller (2009), Gayle, Golan and Miller (2015)
  - moral hazard problem is more severe
  - the quality of signal (about effort) is poorer in larger firms
- Dynamic contract literature
  - moral hazard: Spear and Srivastava (1987), etc.
  - limited commitment: Thomas Worrall (1988, 1990), etc.
- Labor search literature
  - sequential auction: Postel-Vinay and Robin (2002)

Illustrative Model

Two-period Model

Period 1: Moral Hazard Period

- the firm provides incentive pays

Period 2: Market Competition Period

- no moral hazard problem
- executives receive offers from outside firms randomly
- incumbent and outside firms bid for the executive

Moral Hazard Problem

- risk averse executives, $u(w) - c(e)$, where $e \in \{0, 1\}$, $c(1) = c$, $c(0) = 0$
- effort stochastically increases manager's productivity $z \in \mathcal{Z}$
- z follows $\Gamma(z)$ when $e = 1$, and $\Gamma^s(z)$ when **S**hirks
- once first period z is realized, it becomes a constant
- likelihood ratio $g(z) = \Gamma^s / \Gamma$ decreases in z

$$\sum_{z'} u(z')\Gamma(z') - \sum_{z'} u(z')\Gamma^s(z') \geq c$$

$$\sum_{z'} u(z')(1 - g(z'))\Gamma(z') \geq c$$

- one-manager firm
- production $f(s, z) = \alpha s z$ where s is firm size

Two-period Model: Market Competition

Outside firms poach the executives

- for simplicity, with $\lambda \in (0, 1)$ get an offer from $s' > s$

Bertrand competition

- since $s' > s$, executive tansits to s' and get the pay of $\alpha s z$

Two-period Model: Contracting Problem

The firm maximizes

$$\int_z \Big(\alpha sz - w(z)\Big) + \beta\Big[(1-\lambda)\Big(\alpha sz - w_2(z)\Big) + \lambda \times 0\Big] d\Gamma(z)$$

subject to

$$\lambda : \int_z \Big(u(w(z)) - c + \beta(1-\lambda)u(w_2(z)) + \beta\lambda u(\alpha sz)\Big) d\Gamma(z) = u_0$$

$$\mu : \int_z \Big(u(w(z)) + \beta(1-\lambda)u(w_2(z)) + \beta\lambda u(\alpha sz)\Big)(1 - g(z)) d\Gamma(z) \geq c$$

Two-period Model: Optimal Contract

The optimal contract follows

$$w(z) = w_2(z) = \lambda + \mu(1 - g(z)),$$

where μ determines the pay-for-performance incentives

$$\underbrace{\int_z \Big(u(w(z))s + \beta(1 - \lambda)u(w_2(z)) \Big)(1 - g(z))d\Gamma(z)}_{\text{Performance Incentives}}$$

$$+ \underbrace{\int_z \Big(\beta\lambda u(sz)(1 - g(z)) \Big)d\Gamma(z)}_{\text{Market Incentives}} \geq c$$

How binding IC is depends on how large `market incentives` are.

Two-period Model: Market Incentives
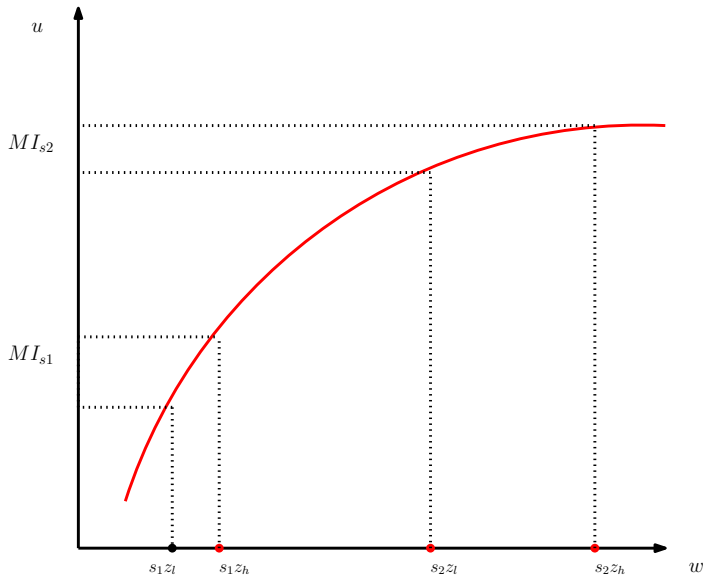
Two-period Model: Market Incentives

Proposition

In the two-period illustrative model, the market-based incentives decrease with firm size iff the utility function has a relative risk aversion

$$-\frac{wu''(w)}{u'(w)} > 1.$$

Towards a Dynamic Model

Two-period Model

- no moral hazard in period 2
- $z_2 = z_1$
- only one outside firm $s' > s$

Dynamic Model

- dynamic moral hazard
- persistent productivity $\Gamma(z, z')$
- outside firm follows $F(s')$

Dynamic Model

Set Up

Executives:

- risk averse, $u(w) - c(e)$, $e \in \{0, 1\}$, $c(1) = c$, $c(0) = 0$
- effort increases individual productivity $z \in \mathcal{Z}$
- z' follows a Discrete Markov Chain Process
  $\Gamma(z, z')$ if $e = 1$, $\Gamma^s(z, z')$ if $e = 0$
  likelihood ratio $g(z, z') = \Gamma^s / \Gamma$ decreases in z'
- die with $\delta \in (0, 1)$, the match break up, job disappears

Firms:

- firm size $s \in \mathcal{S}$, exogenous and permanent
- production $y(s, z) = \alpha s z$

Set Up

Search Market:

- on the job search
- with $\lambda_1 \in (0,1)$ sample an outside firm from $F(s)$

Sequential Auction:

- Bertrand competition between current and outside firms
- Each firm has a bidding frontier, $\bar{W}(z,s)$, defined by
  $\Pi(z,s,\bar{W}(z,s)) = 0$
- $\bar{W}(z,s)$ increase in z and s

Timing
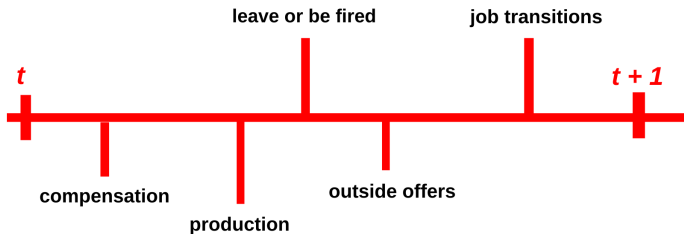
Dynamic Contract

- State at t $h_t = (z_t', s_t, s_t')$, history $h^t = (h_1, h_2, ..., h_t)$
- A feasible contract is a plan that stipulates

$$\{e_t(h^{t-1}), w_t(h^{t-1}), I_t(h^t)\}_{t=0}^{\infty},$$

- Simplifications $\rightarrow \{w_t(h^{t-1})\}_{t=0}^{\infty}$
  - $e = 1$ is always optimal.
  - exclude firing, to be extended.
- Use the executive's beginning-of-period expected utility, V, as a co-state variable

$$\sigma \equiv \{w(V), W(z', s', V) | z' \in \mathbb{Z} \text{ and } V \in \Phi\},$$

Contracting Problem

Firms maximize profits

$$\Pi(z, s, V) = \max_{w, W(z', s')} \sum_{z' \in \mathbb{Z}} \left[\alpha s z' - w + \tilde{\beta} \sum_{s' \in \mathbb{S}} \Pi(z', s, W(z', s')) \tilde{F}(s') \right] \Gamma(z, z')$$

subject to

$$\lambda : V = u(w) - c + \tilde{\beta} \sum_{z' \in \mathbb{Z}} \sum_{s' \in \mathbb{S}} W(z', s') \tilde{F}(s') \Gamma(z, z'), \quad \text{(Promise-K)}$$

$$\mu : \tilde{\beta} \sum_{z' \in \mathbb{Z}} \sum_{s' \in \mathbb{S}} W(z', s') \tilde{F}(s') (1 - g(z, z')) \Gamma(z, z') \geq c. \quad \text{(IC)}$$

$$\mu_0 : W(z', s') \geq \min\{\overline{W}(z', s'), \overline{W}(z', s)\} \quad \text{(PC-Executive)}$$

$$\mu_1 : W(z', s') \leq \overline{W}(z', s). \quad \text{(PC-Firm)}$$

Optimal Contract

The Optimal Contrct

Given the beginning of the period state (z, s, V), the current period compensation is given by w,

$$w : \frac{\partial \Pi(z, s, V)}{\partial V} = -\frac{1}{u'(w)},$$

and the continuation utility follows

$$W(z', s') = \begin{cases} \overline{W}(z', s) & \text{if } \overline{W}(z', s') \geq \overline{W}(z', s) \\ \overline{W}(z', s') & \text{if } \overline{W}(z', s) > \overline{W}(z', s') > W(z') \\ W(z') & \text{if } \overline{W}(z', s) > W(z') \geq \overline{W}(z', s') \end{cases}$$

where $W(z')$ satisfies

$$\frac{\partial \Pi(z', s, W(z'))}{\partial W(z')} = \frac{\partial \Pi(z, s, V)}{\partial V} - \mu(1 - g(z, z')).$$

The Optimal Contrct in terms of wage w

For exhibition, impose $u(w) = \log(w)$, then

$$w(z', s') = \begin{cases} \overline{w}(z', s) & \text{if } \overline{w}(z', s') \geq \overline{w}(z', s) \text{ or } w(z') > w(z', s) \\ \overline{w}(z', s') & \text{if } \overline{w}(z', s) > \overline{w}(z', s') > w(z') \\ w(z') & \text{if } \overline{w}(z', s) > w(z') \geq \overline{w}(z', s') \end{cases}$$

where $w(z') = w(z) + \mu(1 - g(z, z'))$.
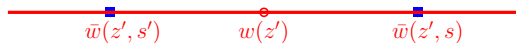
$$w(z', s') = \max\{\min\{w(z), w(\bar{z'}, s)\}, w(\bar{z'}, s')\}$$

$$w(z', s') = w(\bar{z'}, s)$$

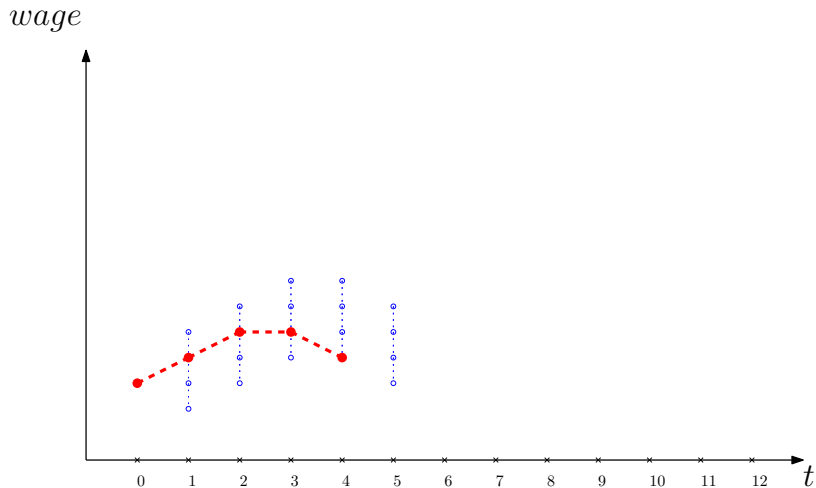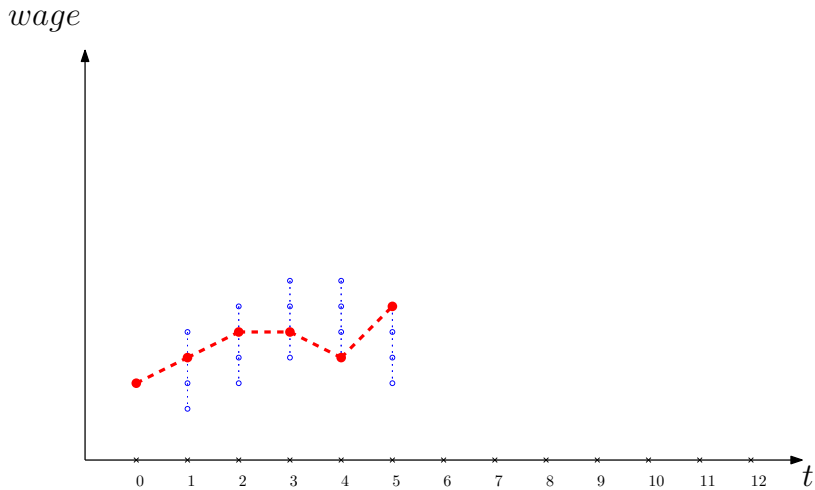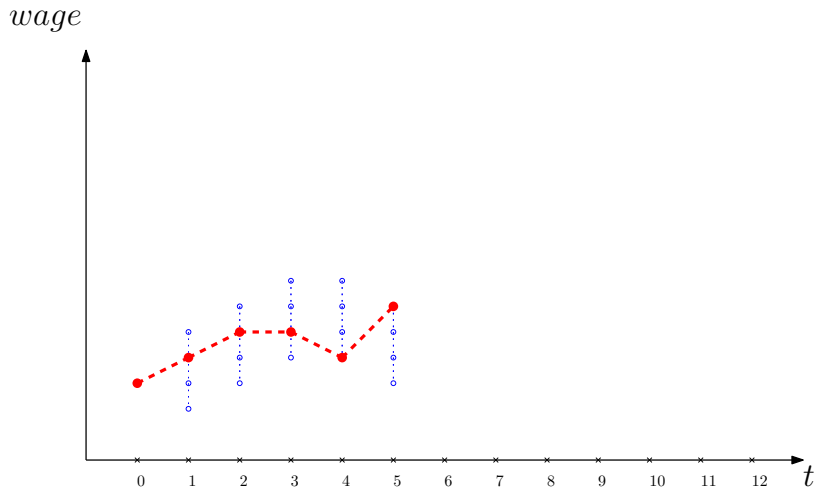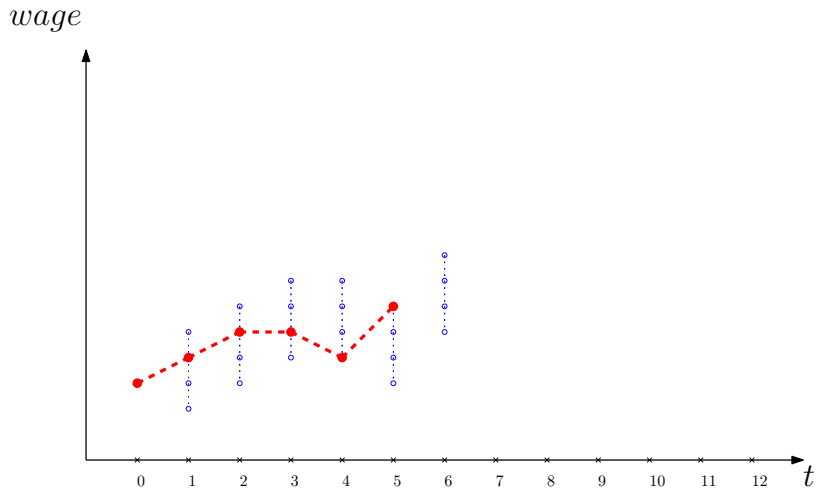## Optimal Contract
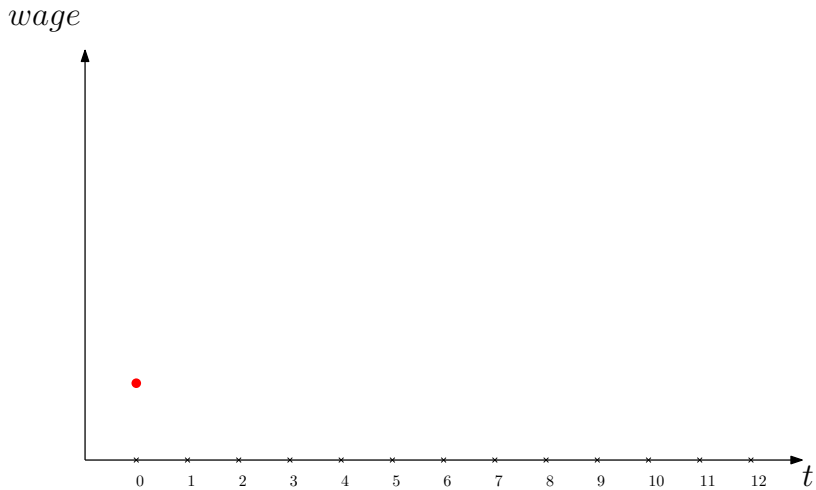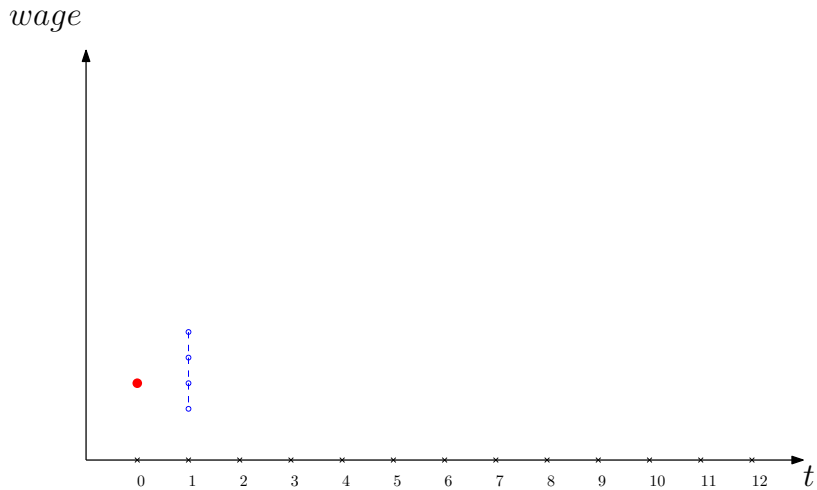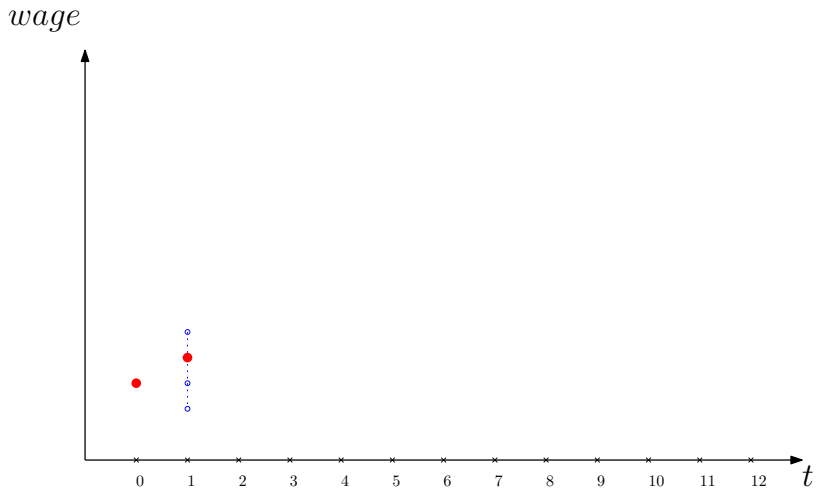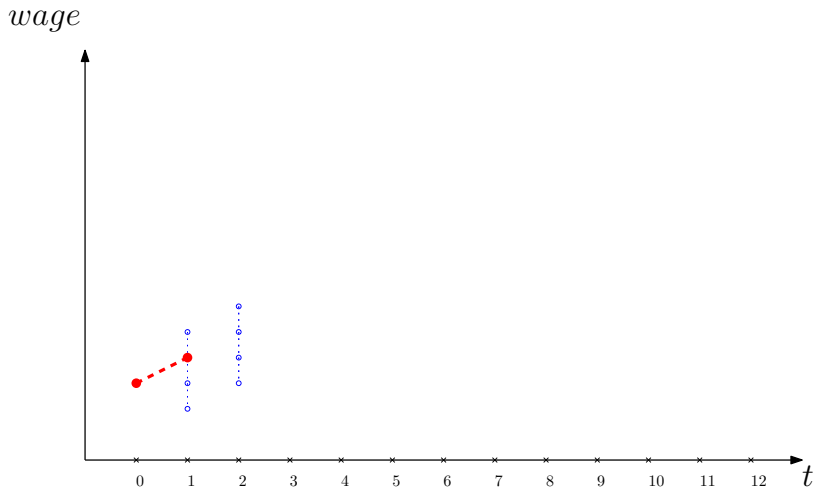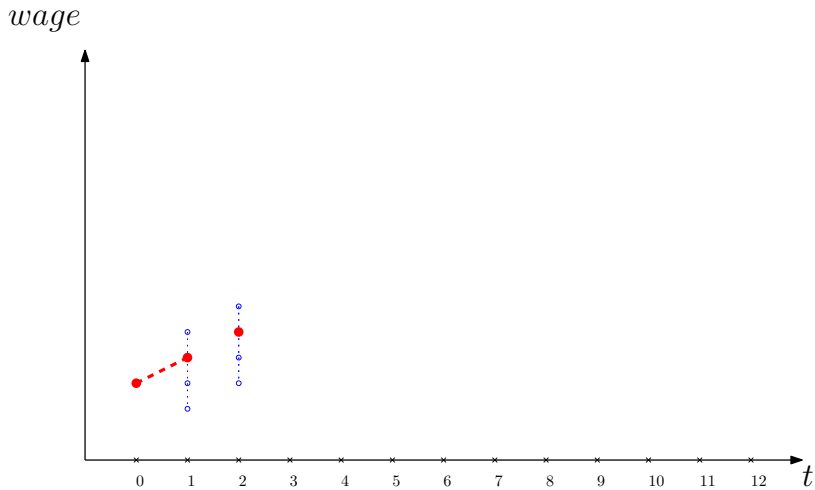
Optimal Contract

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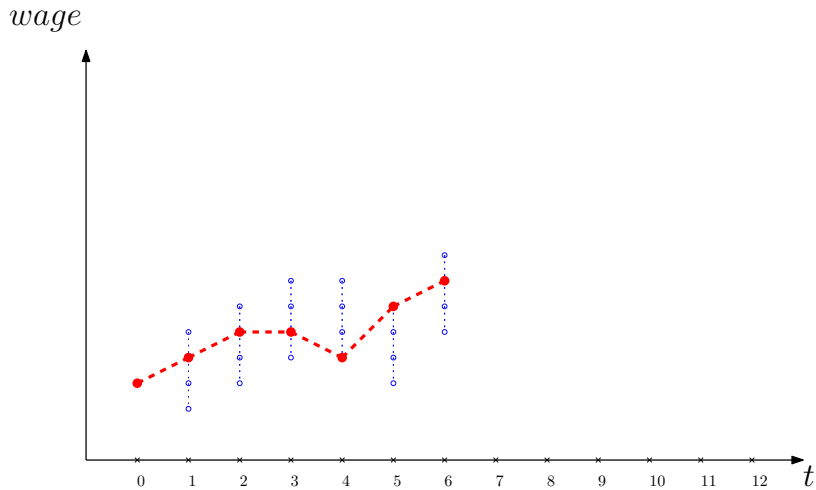# Optimal Contract

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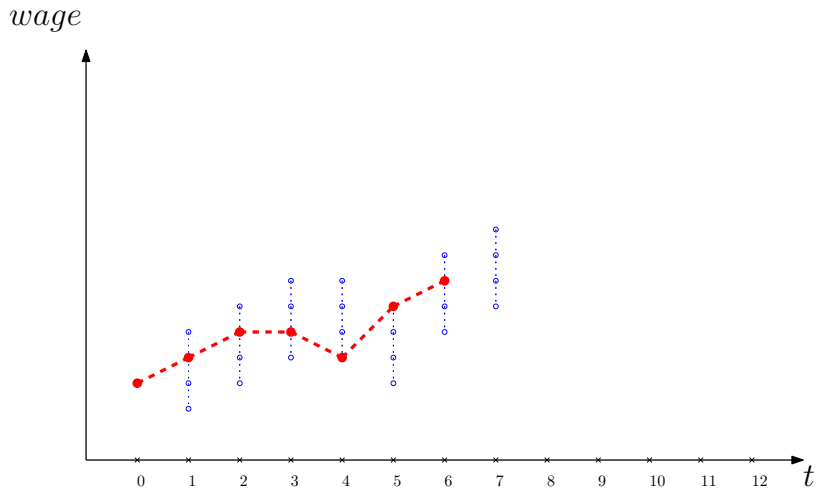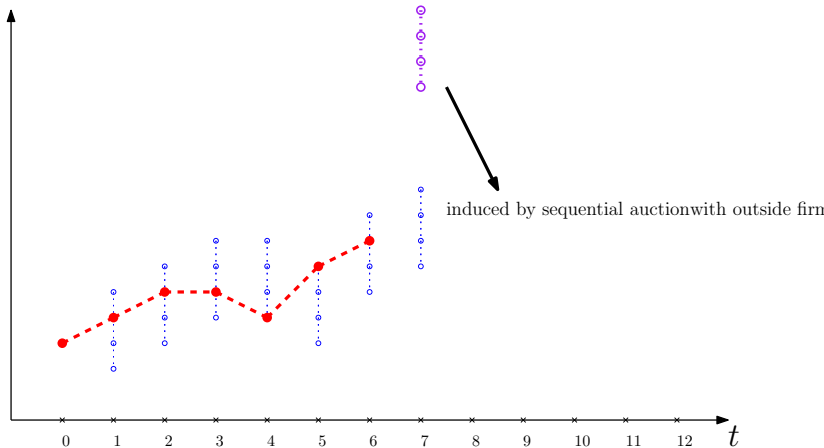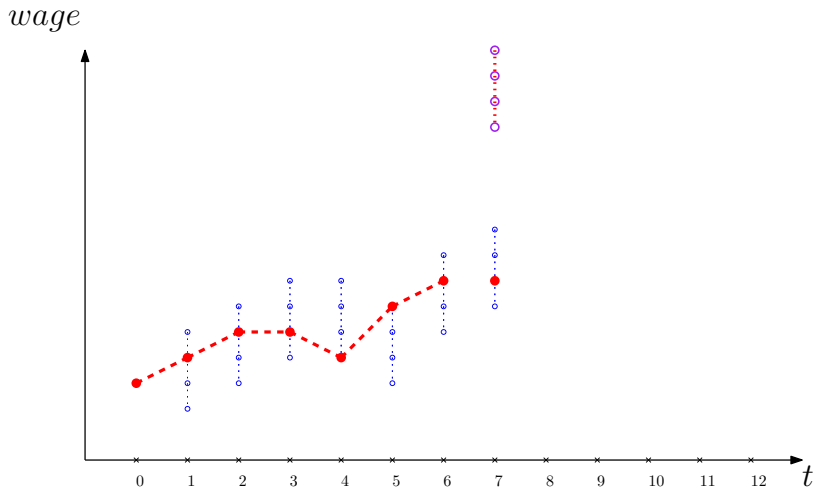
Optimal Contract

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induced by sequential auction with outside firm
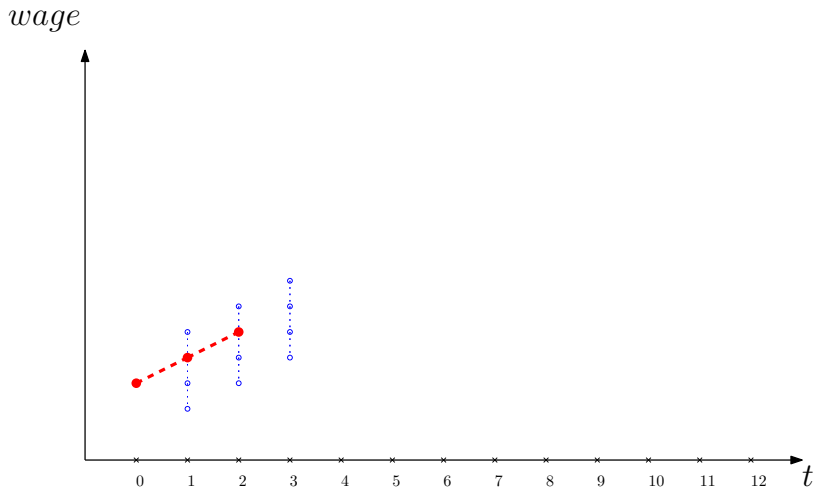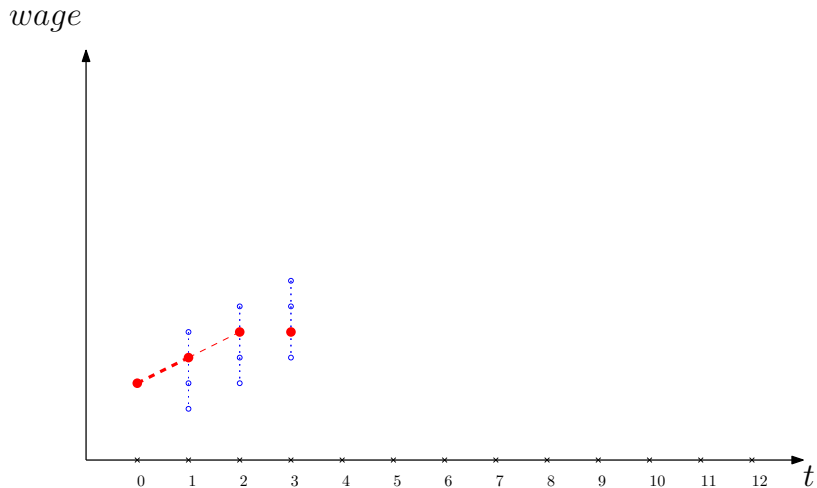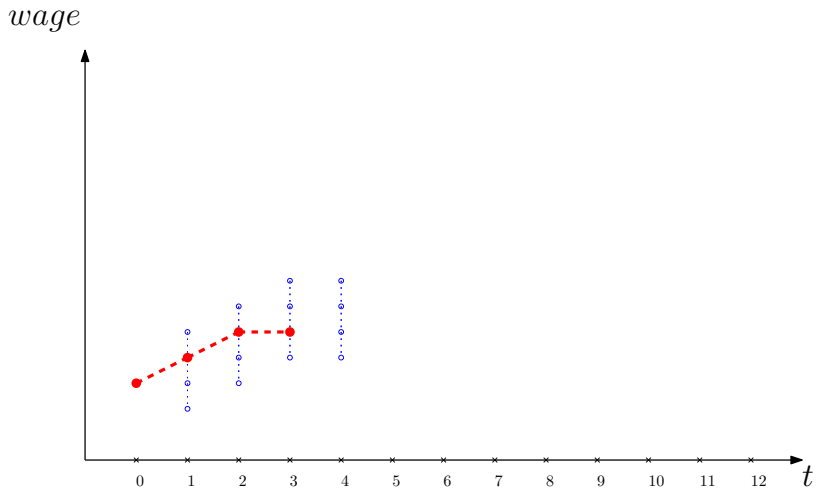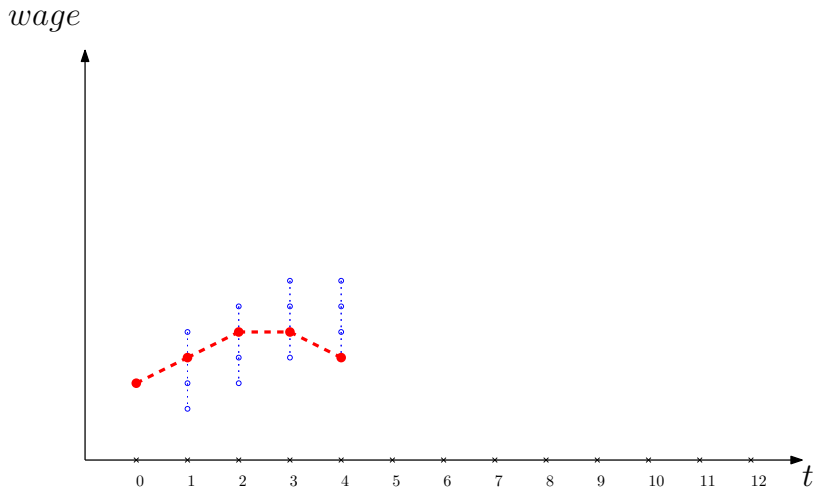
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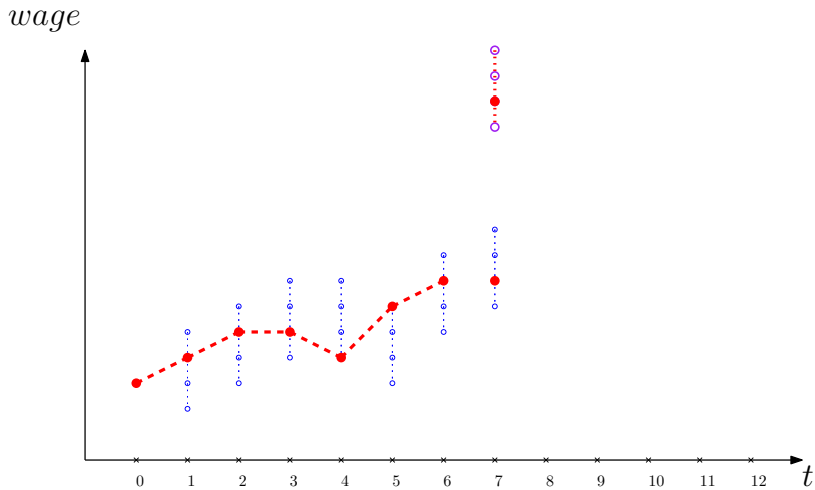*wage*

Optimal Contract

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Optimal Contract

wage
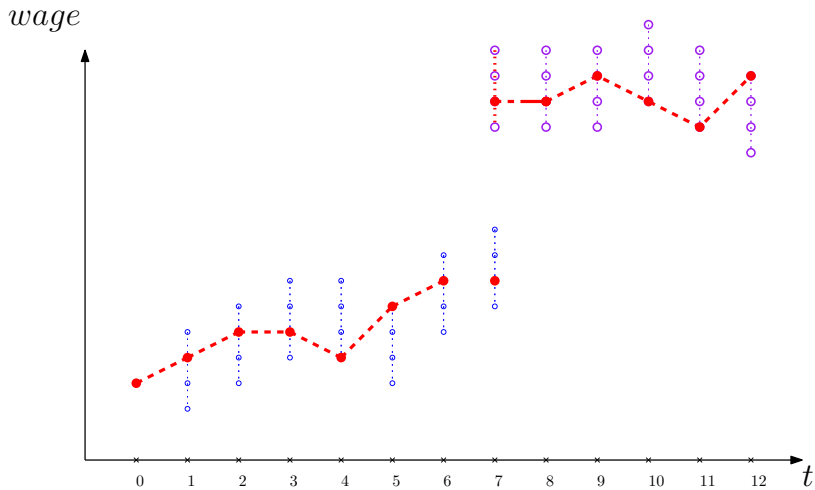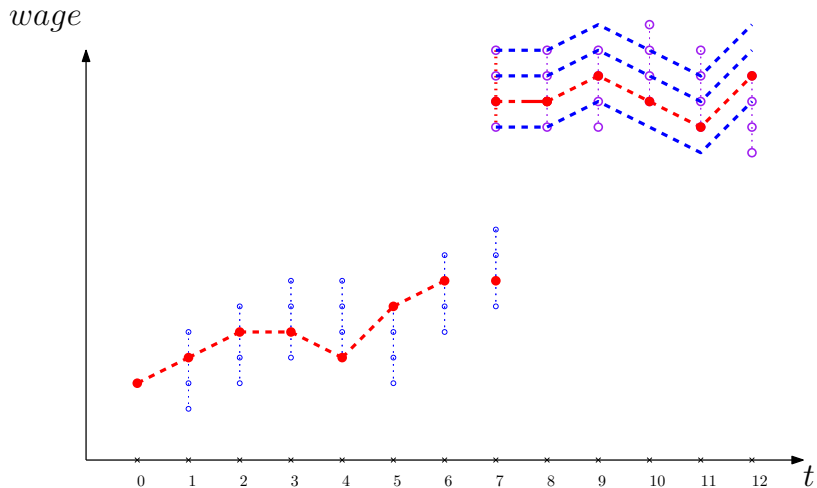
No Moral Hazard, Full Commitment
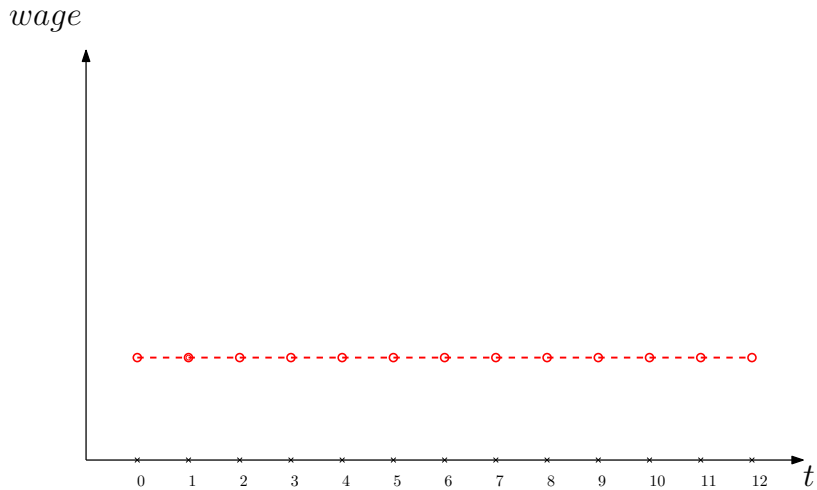
Only Moral Hazard
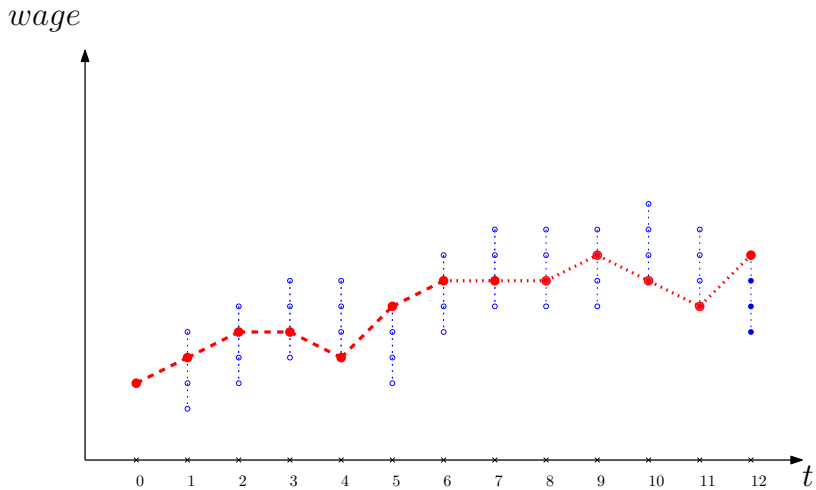
Only Limited Commitment
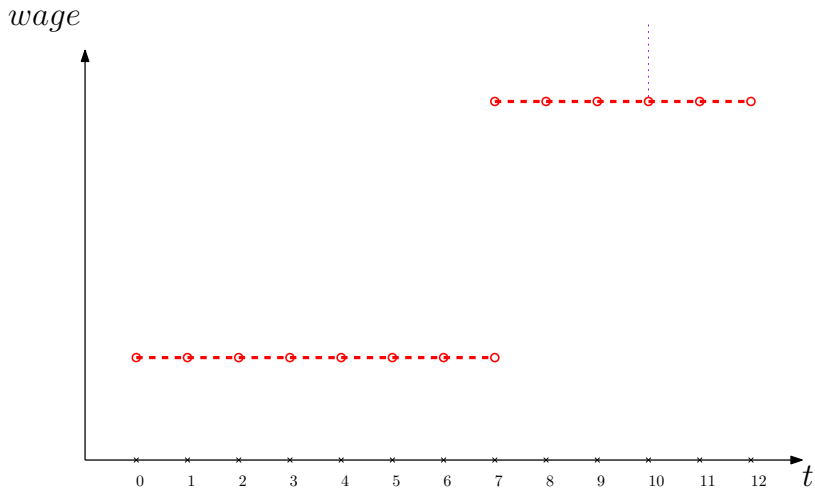
Market-based Incentives

Proposition

The market-based incentives decrease with firm size iff the utility function has a relative risk aversion

$$-\frac{wu''(w)}{u'(w)} > 1.$$
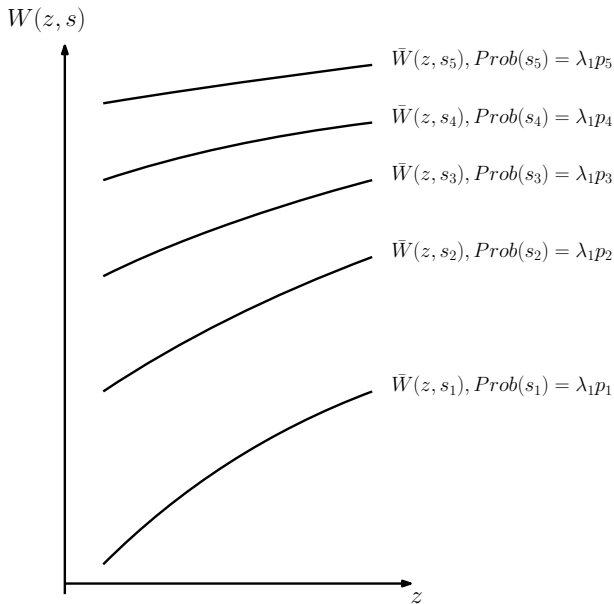
Market-based Incentives decrease with firm size

Market-based Incentives decrease with firm size

$W(z,s)$

$\bar{W}(z,s_5), Prob(s_5) = \lambda_1 p_5$

$\bar{W}(z,s_4), Prob(s_4) = \lambda_1 p_4$

$\bar{W}(z,s_3), Prob(s_3) = \lambda_1 p_3$

$\bar{W}(z,s_2), Prob(s_2) = \lambda_1 p_2$

$\bar{W}(z,s_1), Prob(s_1) = \lambda_1 p_1$

z

Market-based Incentives decrease with firm size

$W(z, s)$

$\bar{W}(z, s_2)$
$Prob(\cdot) = \lambda_1(p_2 + p_3 + p_4 + p_5)$

$\bar{W}(z, s_1), Prob(s_1) = \lambda_1 p_1$

z

Market-based Incentives decrease with firm size

$W(z, s)$

$\bar{W}(z, s_5), Prob(s_5) = \lambda_1 p_5$

$\bar{W}(z, s_4), Prob(s_4) = \lambda_1 p_4$

$\bar{W}(z, s_3), Prob(s_3) = \lambda_1 p_3$

$\bar{W}(z, s_2), Prob(s_2) = \lambda_1 p_2$

$\bar{W}(z, s_1), Prob(s_1) = \lambda_1 p_1$

z

54

Market-based Incentives decrease with firm size

$W(z,s)$

$\bar{W}(z, s_3)$
$Prob(s_3 + s_4 + s_5) = \lambda_1(p_3 p_4 + p_5)$

$\bar{W}(z, s_2), Prob(s_2) = \lambda_1 p_2$

$\bar{W}(z, s_1), Prob(s_1) = \lambda_1 p_1$

z
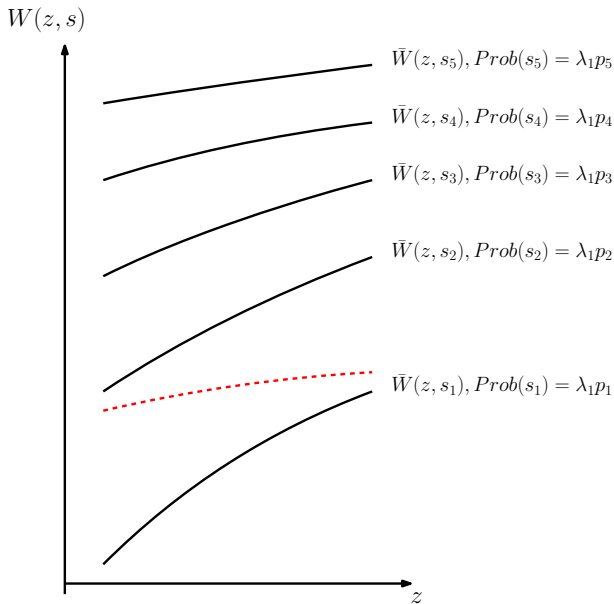
Estimation

Moments and Estimation

Moments	Target	Model	Estimates	Standard Error
Exit Rate	0.0691	0.0691	$\delta = 0.0691$	0.0012
EE Rate	0.0523	0.055	$\lambda_1 = 0.2759$	0.0017
$\hat{\rho}_z$	0.8111	0.5499	$\rho_z = 0.7$	0.0036
Mean(z)	0.1284	0.1763	$\mu_z^w = 0.06$	0.0006
Var(z)	0.0141	0.0141	$\sigma_z = 0.12$	0.0014
Mean(log(wage))	7.17714	6.5241	$\mu_s = 1.7847$	0.228385
Mean(log(size))	7.44379	8.7934	$\sigma_s = 1.3982$	0.0314657
$\beta_{wage-size}$	0.370295	0.3196		
Mean(log(delta))	4.01842	3.8080		
$\beta_{delta-size}$	0.297673	0.2941	$c = 1.91385$	0.0259
$\beta_{delta-wage}$	0.717209	2.1228	$\sigma = 2.50748$	0.0046
Mean($delta > 0$)	0.994725	0.9844		

Model Fit

Simulation (all groups)
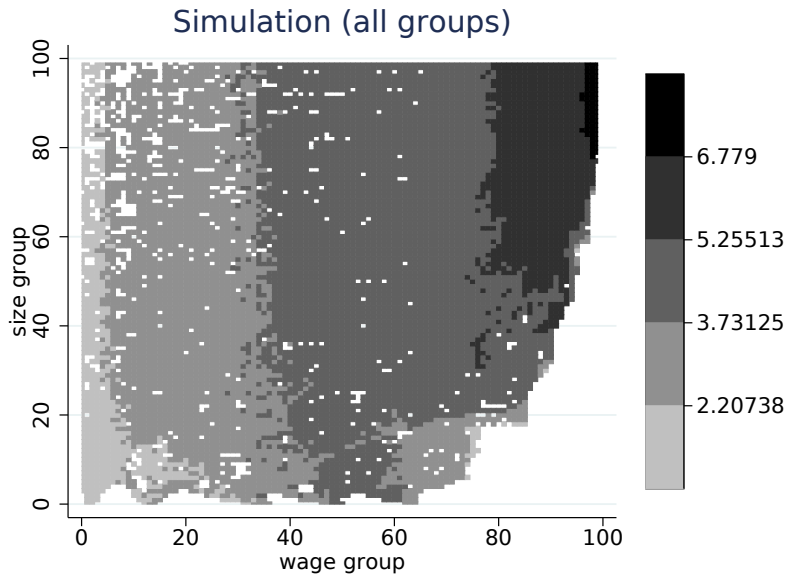
Model Fit
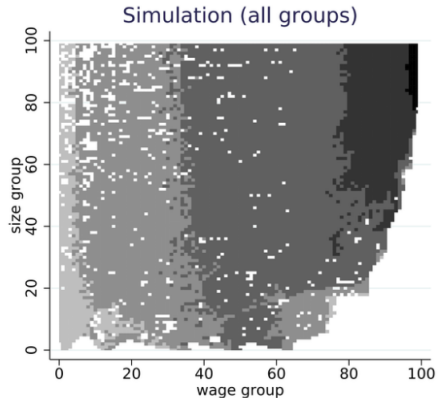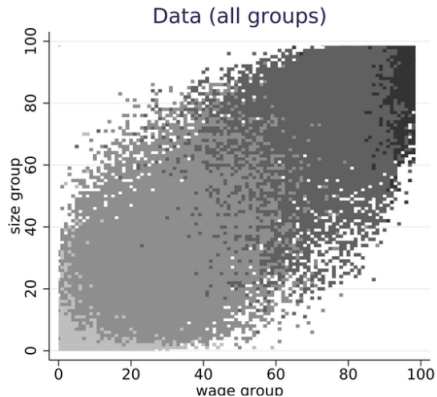
Conclusion

Summary

- Executives are motivated by `performance-based incentives` and `market-based incentives`.
- `Market-based incentives` is smaller in larger firms. So the larger firms need more performance-based pays.
- The model can fit the size premium very well and generate the reasonable `delta` over firm size and total compensation.

Questions?

CEO's of "Small Firms" in S&P 500

+--+
 tdc1: total compensation
 delta: dollar-percentage incentives
+--+

Company	Market Cap millions	tdc1 000's	delta 000's/%
INCYTE CORP	446.408	2432.9734	60.939838
WESTROCK CO	547.828	2800.668	130.96215
ENVISION HEALTHCARE CORP	678.6906	1777.991	217.729
PRICELINE GROUP INC	886.0817	1775.531	165.73476
LKQ CORP	889.9763	2602.093	473.70974
REGENERON PHARMACEUTICALS	897.3801	3094.134	566.14187
SKYWORKS SOLUTIONS INC	1113.547	2638.243	128.10688
CENTENE CORP	1130.155	4584.605	344.02299
ALASKA AIR GROUP INC	1194.977	950.098	99.525198
HOLOGIC INC	1276.448	2709.708	428.10996
ACUITY BRANDS INC	1328.171	1102.528	133.42285
ANSYS INC	1368.129	3738.803	431.01562
GARTNER INC	1474.909	8945.338	158.65569

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  CEO's of "Large Firms" in S&P 500
+----------------------------------------------------------------+
  tdc1: total compensation
  delta: dollar-percentage incentives
+----------------------------------------------------------------+
|                     Company   Market Cap       tdc1      delta |
|                                 millions      000's    000's/%|
|----------------------------------------------------------------|
|               TIME WARNER INC    79965.89  18545.215  1212.9513 |
|                 CONOCOPHILLIPS   80163.26  35442.729  4520.5571 |
|     UNITED PARCEL SERVICE INC    82439.55   3120.042  340.01132 |
|   VERIZON COMMUNICATIONS INC    83233.88      19425  861.09722 |
|                 HOME DEPOT INC    86128.2  35750.103  2014.3633 |
|                       AT&T INC    94944.89  17283.529  1666.3201 |
|                   COCA-COLA CO    95494.39   12781.61  425.62199 |
|                    PEPSICO INC    97836.48  15268.415  2919.7995 |
|              CISCO SYSTEMS INC   121238.6   16269.85  5981.3853 |
|                   CHEVRON CORP    126749.6  13125.882  1106.6351 |
|   INTL BUSINESS MACHINES CORP   129381.2  21693.615  1298.8777 |
|                     INTEL CORP   147738.2   6101.835  1874.5755 |
|             WAL-MART STORES INC  192048.2  16652.894  1465.7708 |
|                 EXXON MOBIL CORP  344490.6  48922.808   3843.027 |
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