Why Do Bigger Firms Pay More For Performance?

Performance-based versus Market-based incentive

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Introduction

Executive Labor Market and Contract incentive

- 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 incentive:

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

- Firm size premium in performance-based incentive

  `delta increases in firm size,`

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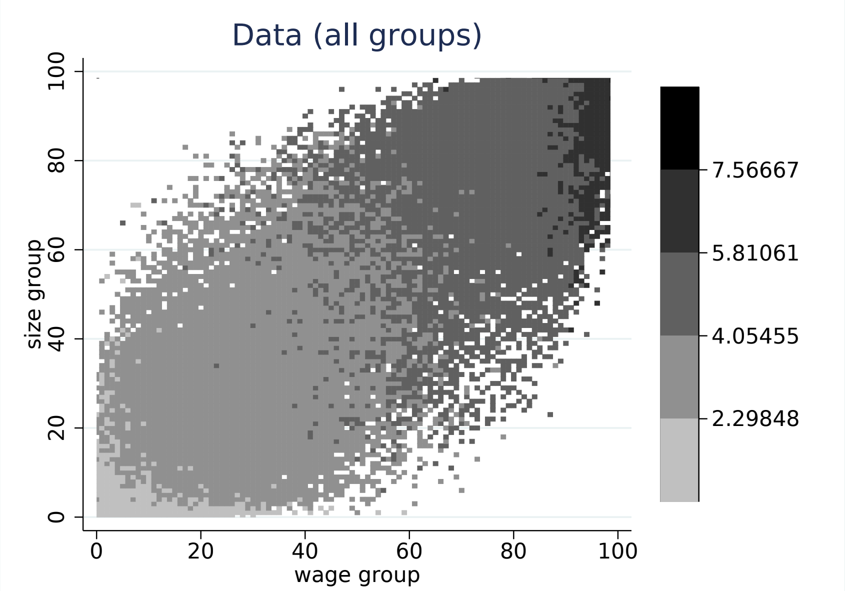
- Firm size premium in performance-based incentive

  `delta increases in firm size, controlling for total compensations`

Motivating Fact: Size Premium



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 $\times$ 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***

Summary

Motivating Facts:

- Size premium exists *controlling for total compensations.*
- Size premium is larger in industries where the executive labor market is more active.

Summary

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- Size premium exists *controlling for total compensations.*
- Size premium is larger in industries where the executive labor market is more active.

Research Question:

- Why do larger firms pay more for performance?

What do I do?

1. Model: executive labor market and contract incentive
   - how do career concerns and performance-based incentive interact
   - firm size premium in performance-based incentive
2. Estimate: take the model to US executives data (ExecuComp)
3. Evaluations: work on counter-factual
   - regulations on executive compensation
   - contagion effect of corporate governance on executive compensation

Key Elements in the Model

$$\texttt{Firm} \quad \left[\begin{array}{c}\texttt{Dynamic} \\ \texttt{Moral Hazard}\end{array}\right] \quad \texttt{Executive}$$

Key Elements in the Model

Search Frictional
Labor Market

Firm $\left[\begin{array}{c}\text{Dynamic}\\ \text{Moral Hazard}\end{array}\right]$ Executive

Performance-based
Incentives

Market-based
Incentives

Key Elements in the Model

Market competition generates incentive

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

Market-based incentive 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 incentive is lower 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

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 transits to s' and gets a pay of $\alpha s z$

Contracting Problem

The firm maximizes

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

subject to

$$\lambda : \int_z \left\{ \left[u(w(z)) - c\right] + \beta\left[(1-\lambda)u(w_2(z)) + \lambda u(\alpha sz)\right]\right\} d\Gamma(z) = u_0$$

$$\mu : \int_z \left\{ u(w(z)) + \beta\left[(1-\lambda)u(w_2(z)) + \lambda u(\alpha sz)\right]\right\} (1 - g(z)) d\Gamma(z) \geq c$$

Optimal Contract

The optimal contract follows

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

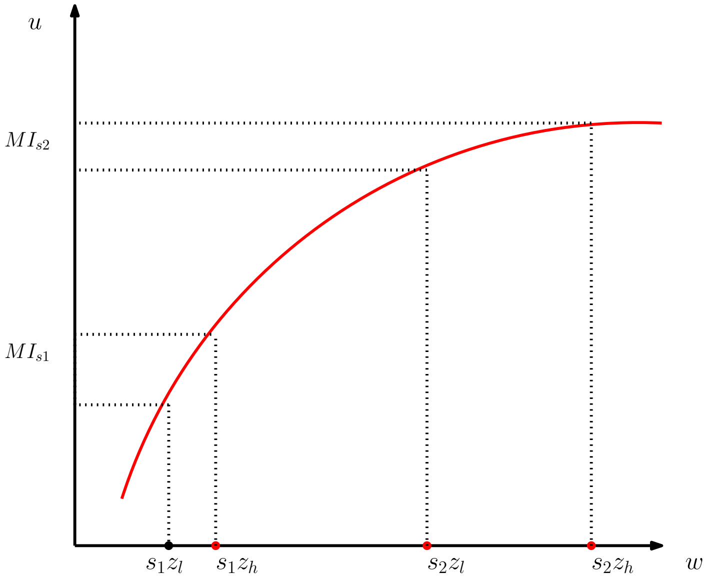
where μ determines the pay-for-performance incentive

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

$$+ \underbrace{\int_z \Big[\beta\lambda u(\alpha s z)\Big](1 - g(z)d\Gamma(z)}_{\text{Market-based incentive}} \geq c$$

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

Compare Market Incentive between $s_1 < s_2$



Market Incentive Decreases in Firm Size

Proposition

In the two-period model, the market-based incentive decreases with firm size iff the utility function has a relative risk aversion larger than 1

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

Towards a Dynamic Model

Why go dynamics?

- Match the data.
  Two-period model is too simple to generate the moments.
- Job ladder equilibrium effect.
  The maximum values a firm is willing to bid depends on the market competition that it faces, in particular the bidding values of those firms higher on the job ladder.
- Study the contagion effects.
  Because of the equilibrium effect, we can study how do large firms' improvement in corporate governance change the incentive compensations in the whole industry.

Towards a Dynamic Model

Two-period Model

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

Dynamic Model

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

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

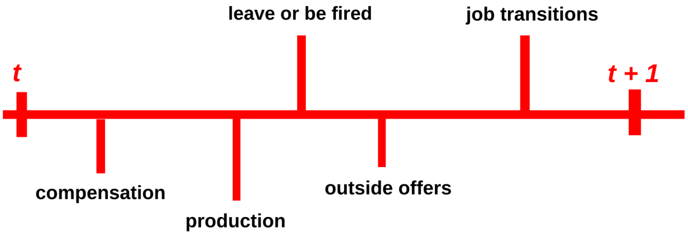
Search Market:

- 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 $\Pi(z, s, \bar{W}(z, s)) = 0$
- $\bar{W}(z, s)$ increases in z and s

Timing


leave or be fired
job transitions
t
t + 1
compensation
production
outside offers

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

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

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

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

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

Optimal Contract

The Optimal Contract

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

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

Contracting Problem

Insert in the optimal contract, the participation constraint becomes

$$V = u(w) - c + \tilde{\beta} \sum_{z'} \left[\lambda_1 \sum_{s' \in \mathcal{M}_1} F(s') \overline{W}(z', s) + \lambda_1 \sum_{s' \in \mathcal{M}_2} F(s') \overline{W}(z', s') \right.$$

$$\left. + \Big(1 - \lambda_1 \sum_{s' \in \mathcal{M}_1 \cup \mathcal{M}_2} F(s') \Big) W(z') \right] \Gamma(z, z'), \tag{PKC}$$

and the incentive compatibility constraint becomes

$$\tilde{\beta} \sum_{z'} \left[\lambda_1 \sum_{s' \in \mathcal{M}_1} F(s') \overline{W}(z', s) + \lambda_1 \sum_{s' \in \mathcal{M}_2} \overline{W}(z', s') F(s') \right.$$

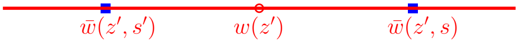
$$\left. + \Big(1 - \lambda_1 \sum_{s' \in \mathcal{M}_1 \cup \mathcal{M}_2} F(s') \Big) W(z')(1 - g(z, z')) \right] \Gamma(z, z') \geq c. \tag{IC'}$$

The Optimal Contrct in terms of wage w

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

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

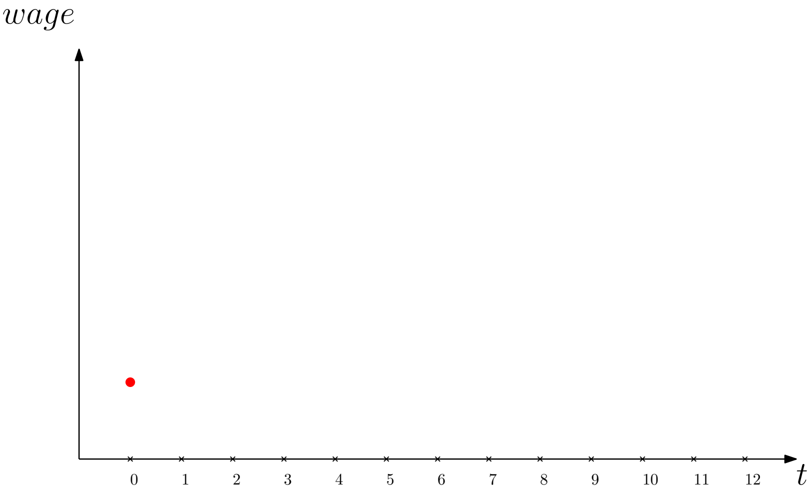
where $w(z') = w(z) + \mu(1 - g(z, z'))$.



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

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

Optimal Contract



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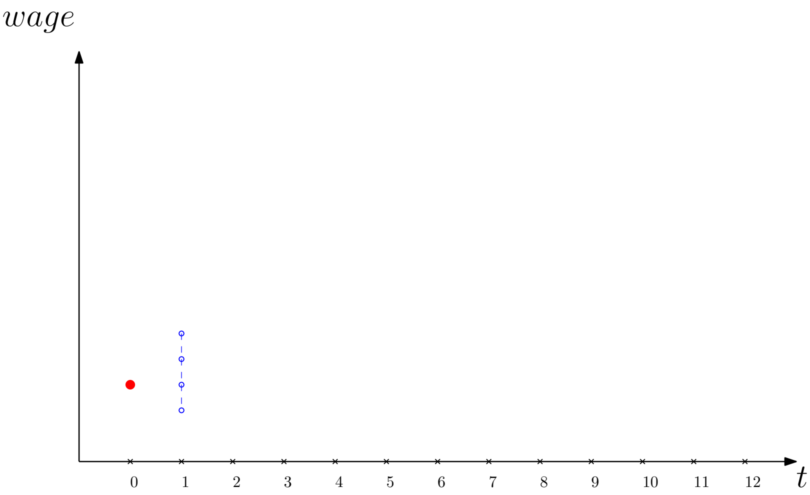

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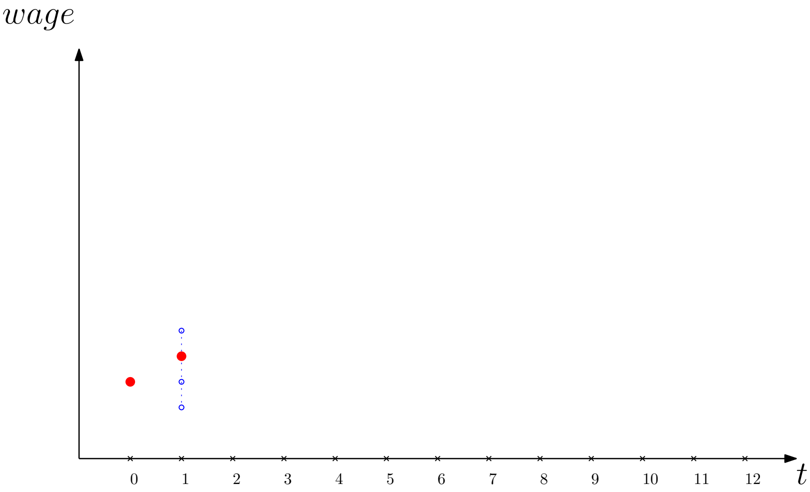

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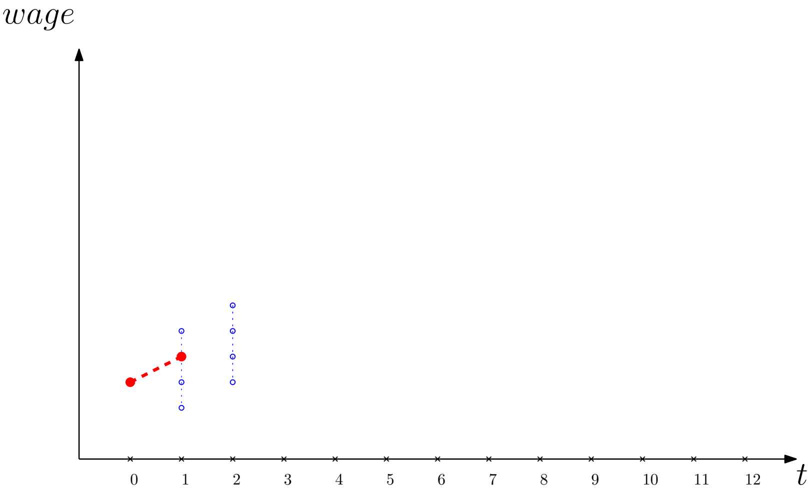

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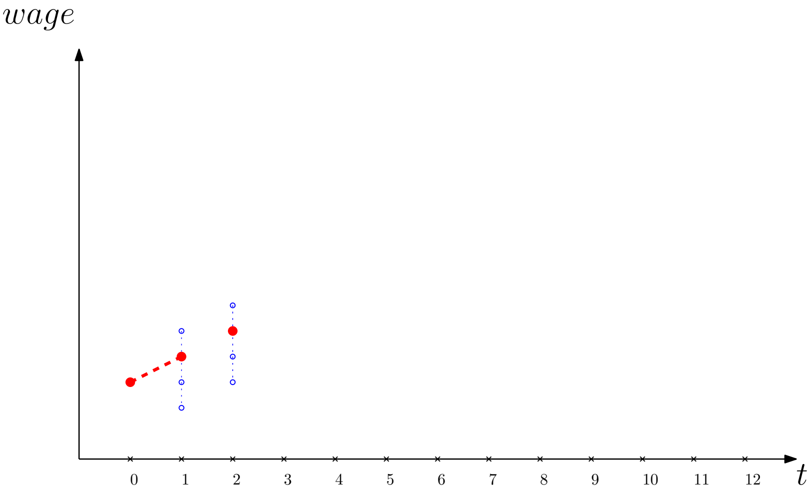

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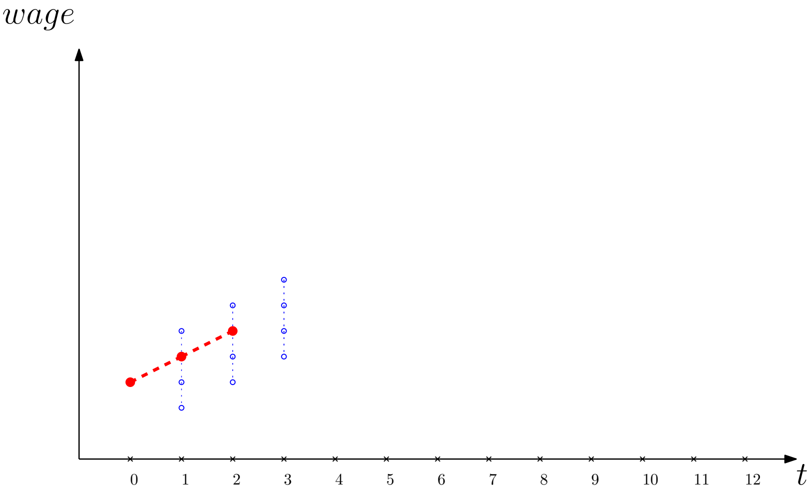

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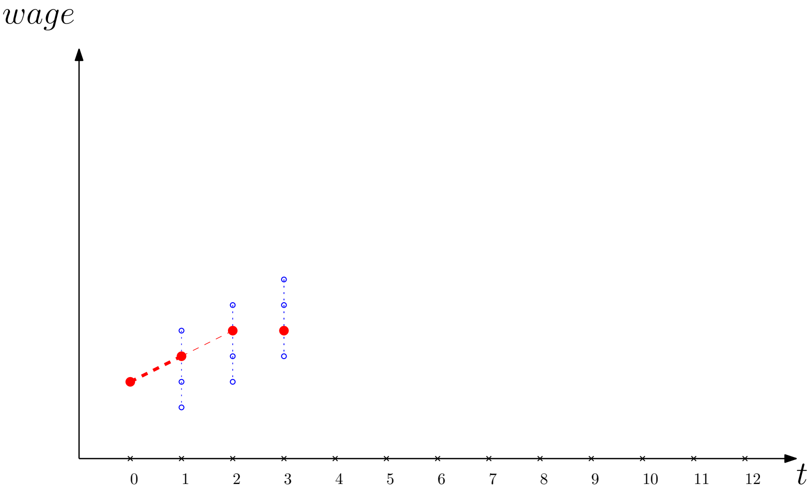

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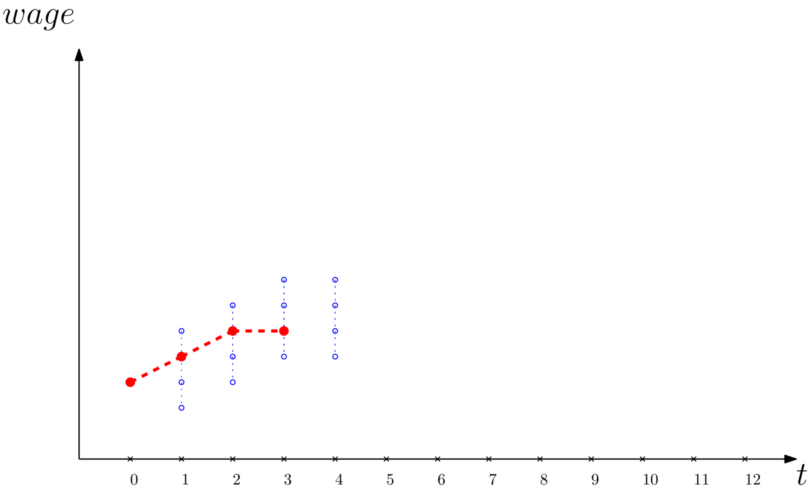

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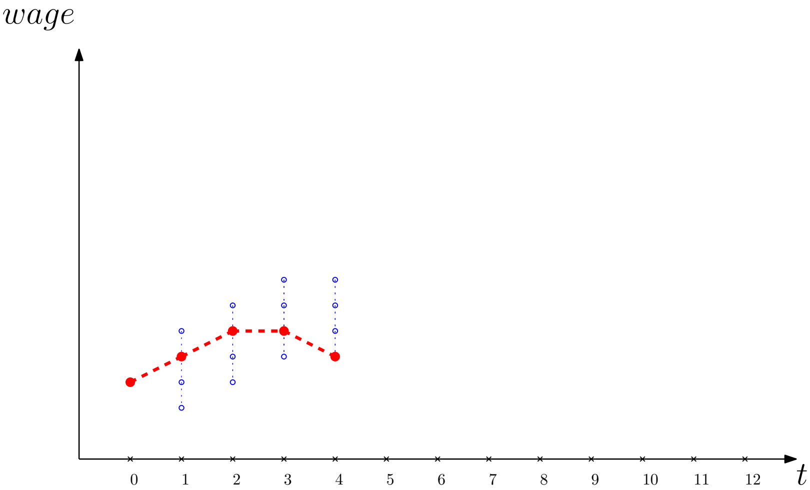

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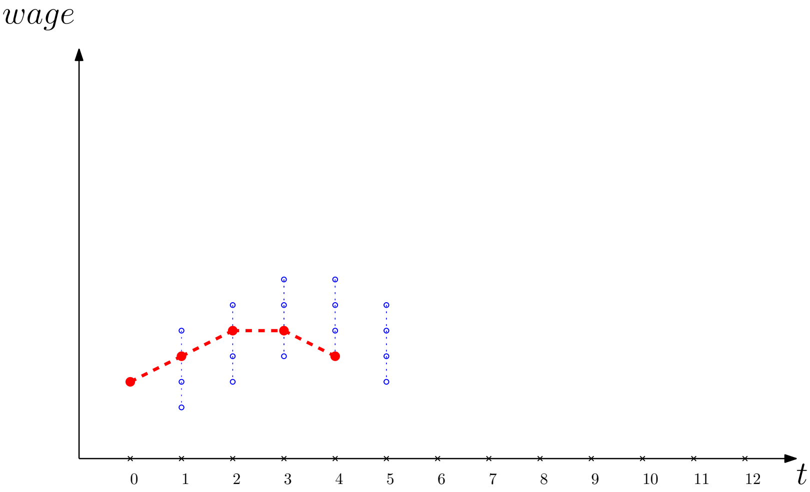

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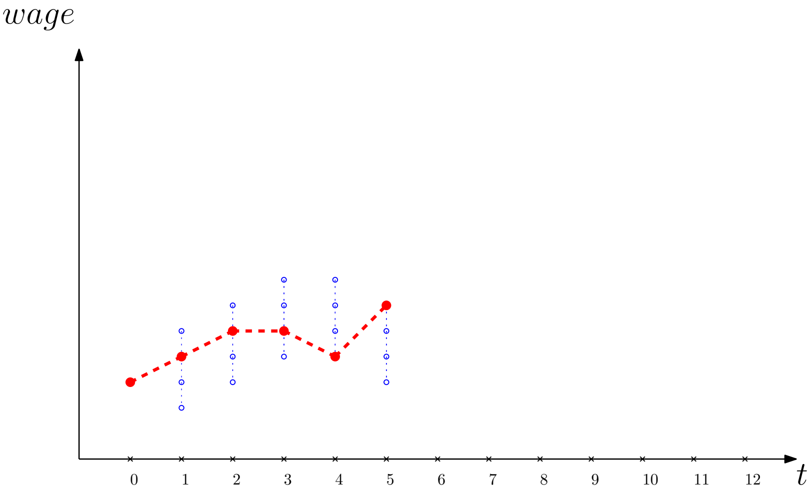

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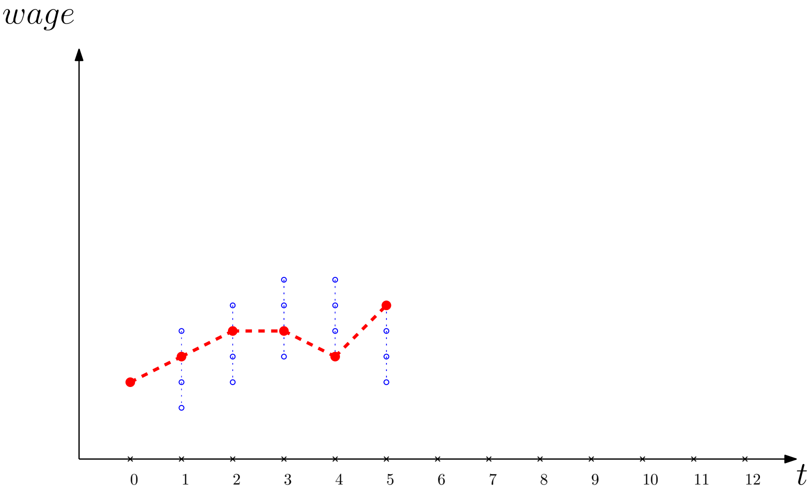

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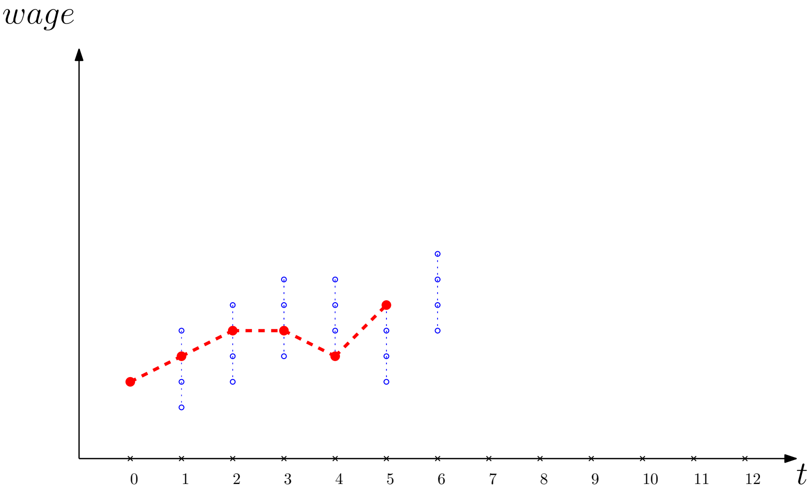

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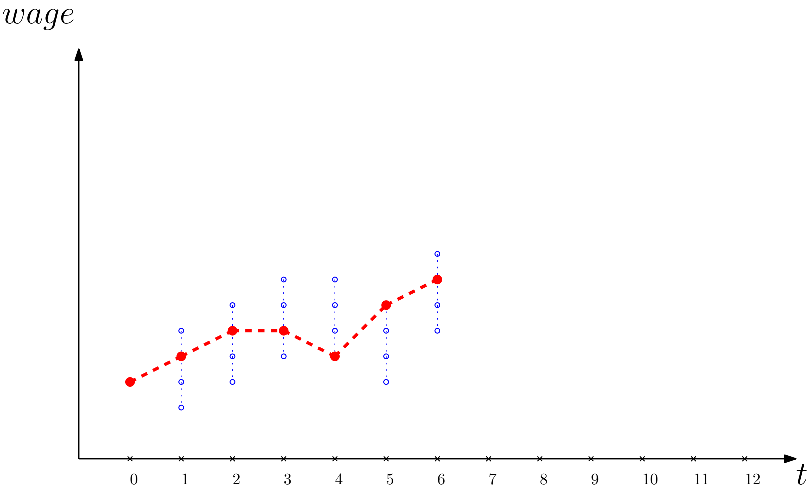

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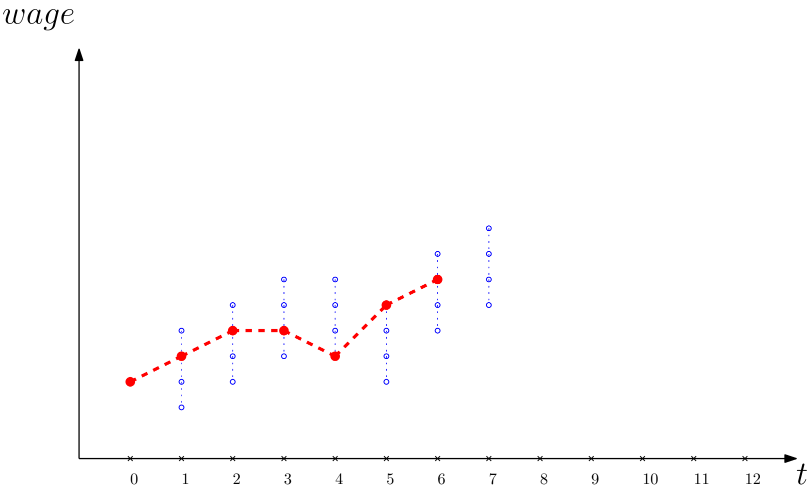

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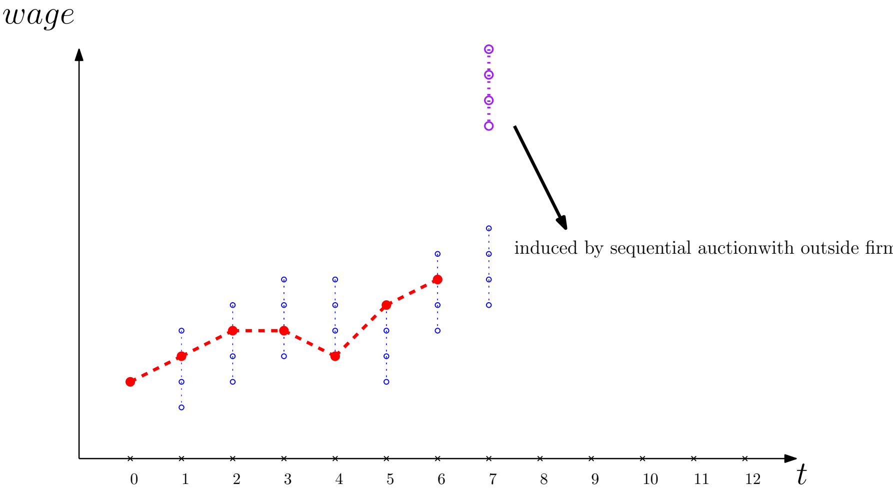

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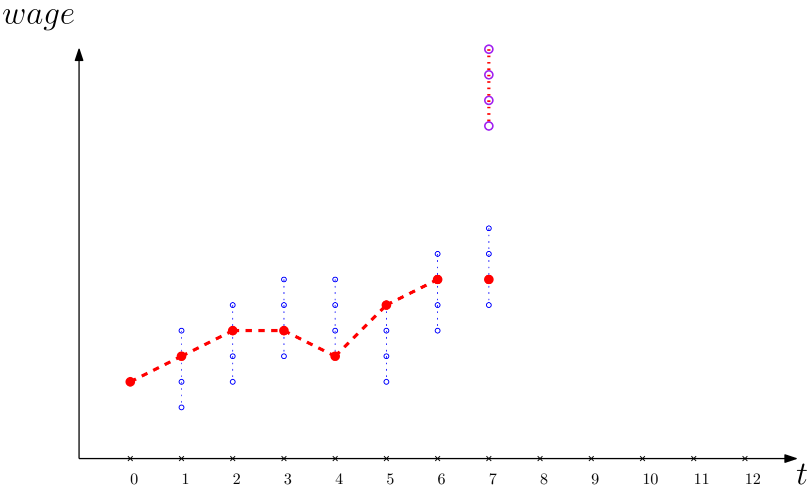

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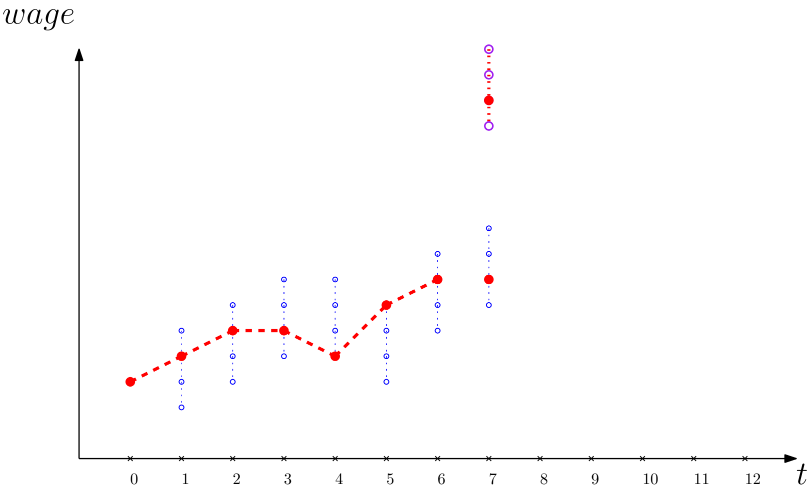

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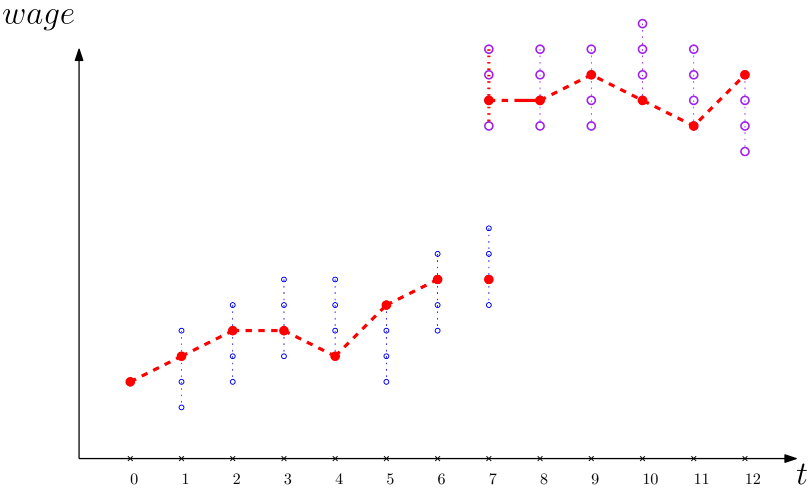

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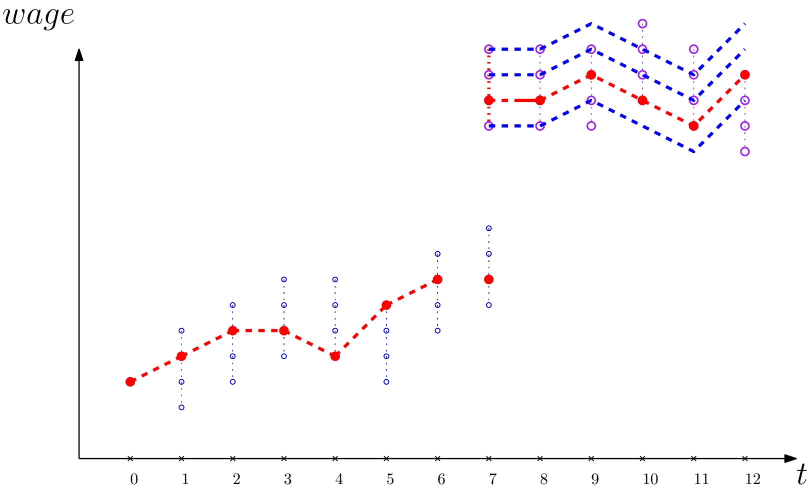
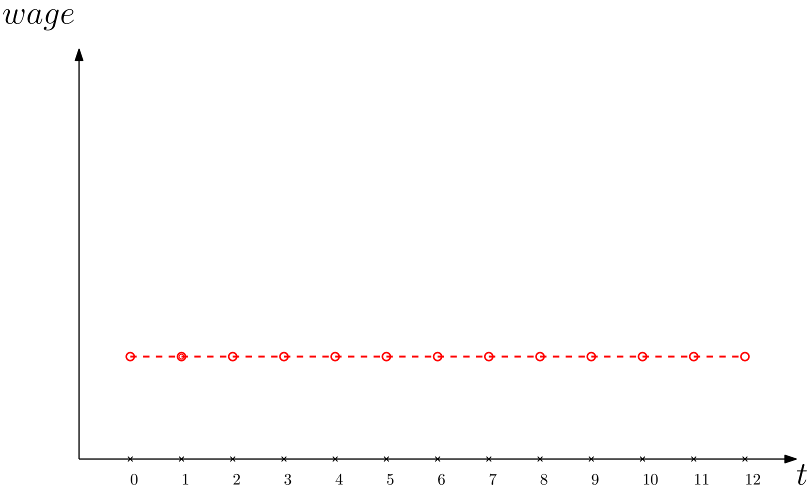
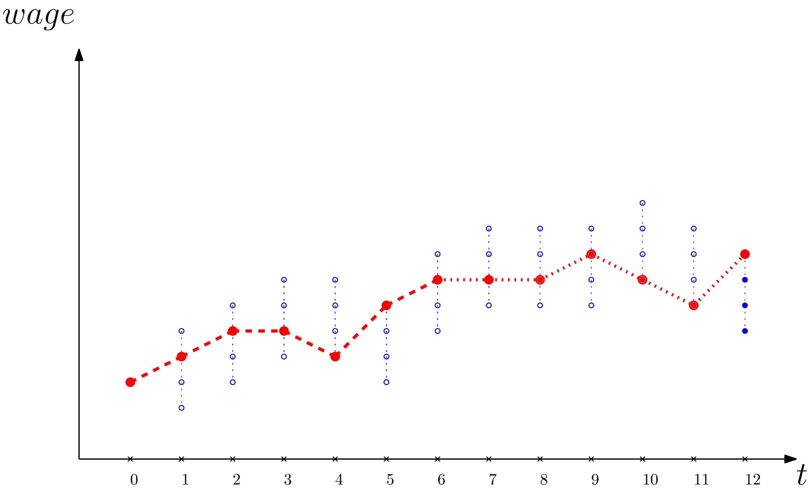


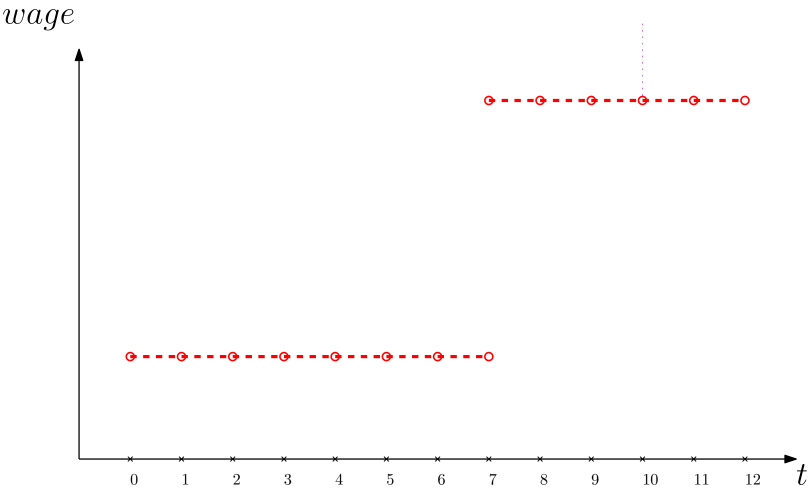
No Moral Hazard, Full Commitment



Only Moral Hazard



Only Limited Commitment



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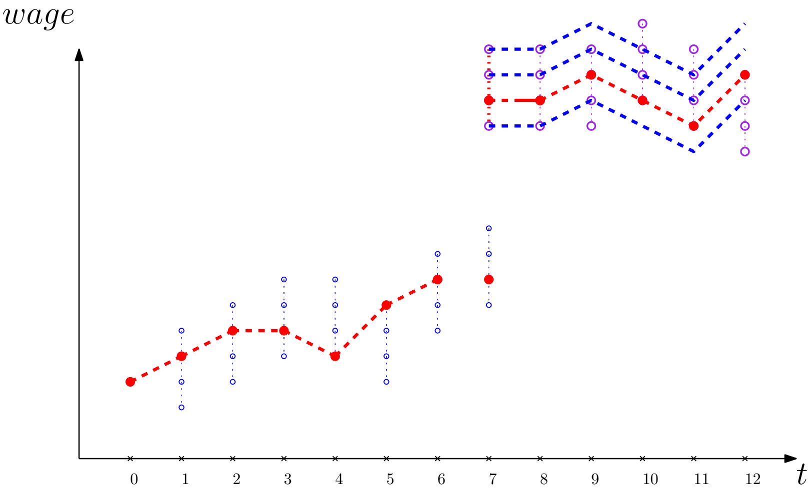


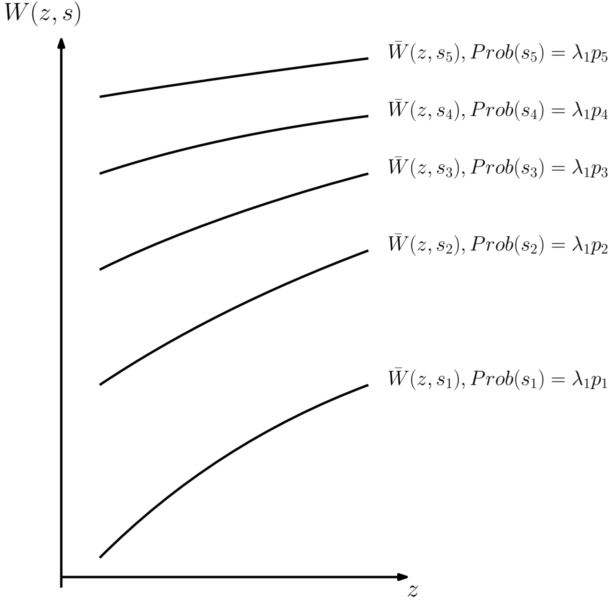
Market-based incentive

Proposition

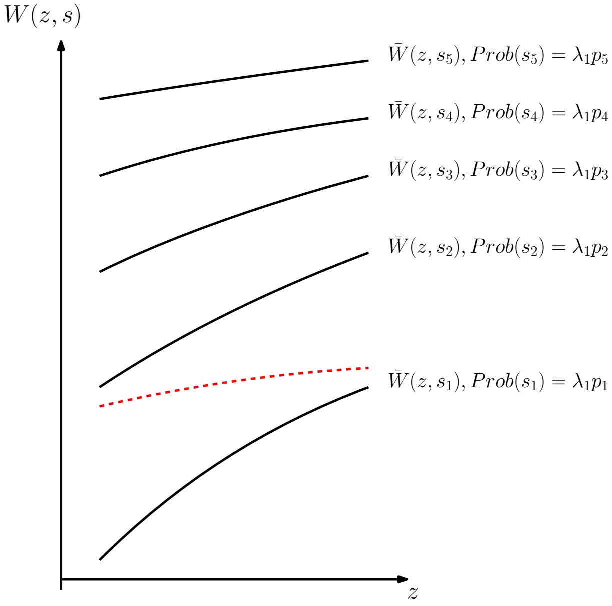
The market-based incentive decrease with firm size iff the utility function has a relative risk aversion

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

Bidding Frontier is Flatter as Firm is larger



Market-based Incentive for Executive in Firm s_2



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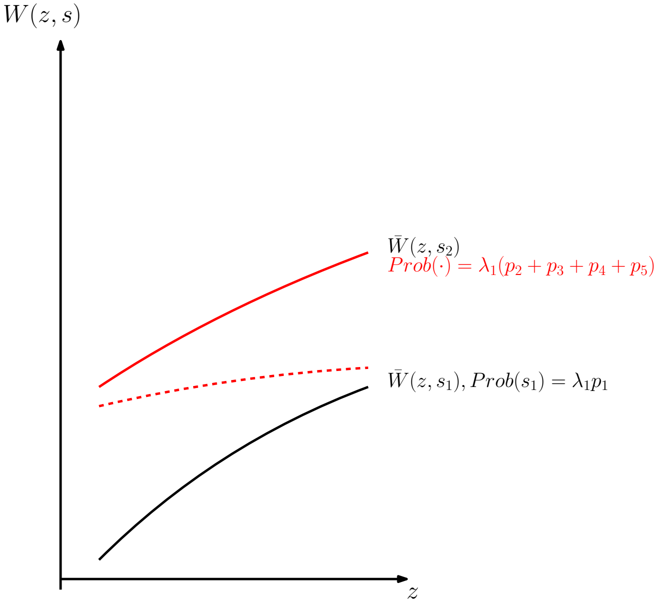
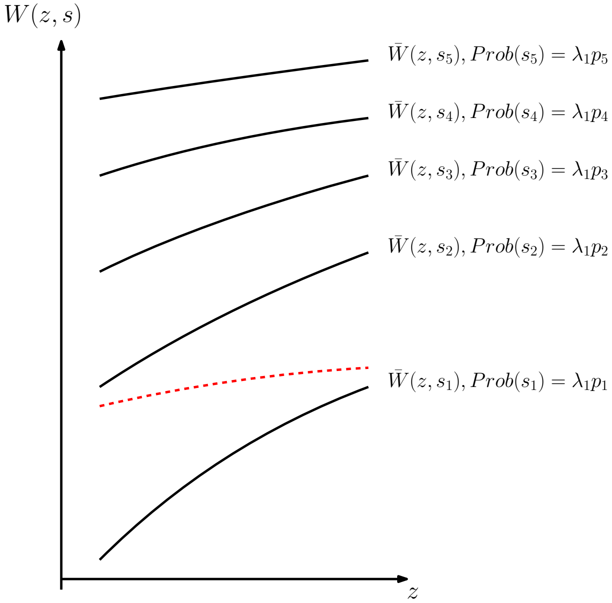
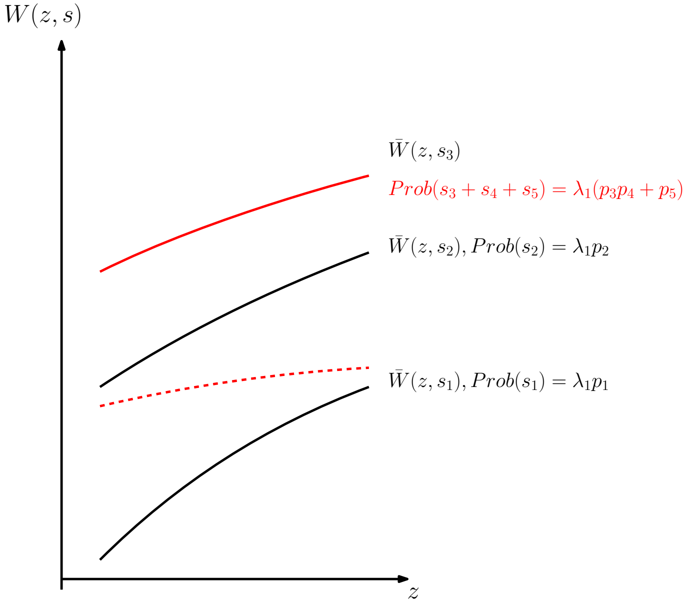


Market-based Incentive for Executive in Firm s_3



Market-based Incentive for Executive in Firm s_3

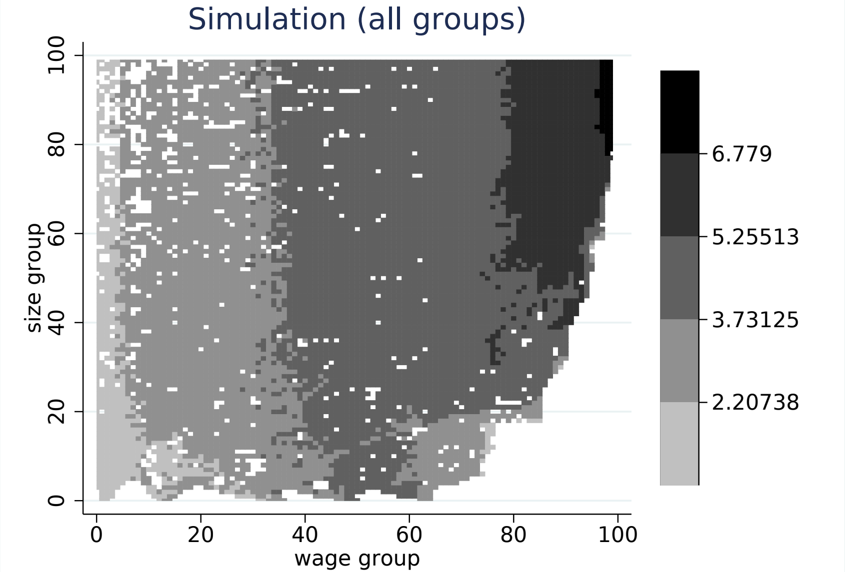


Estimation

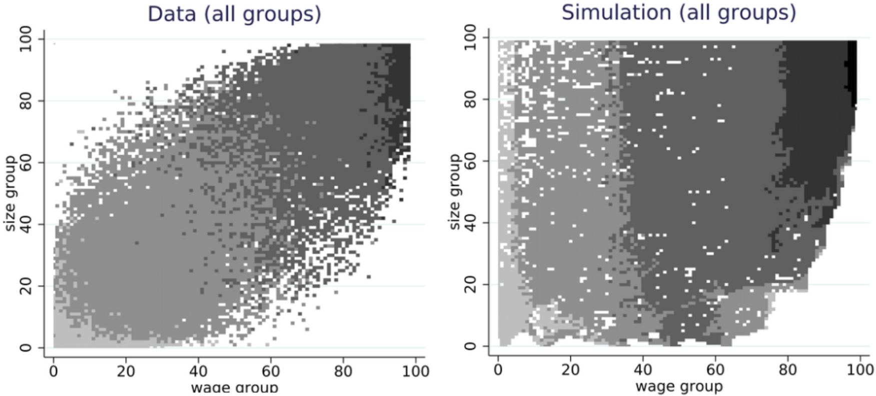
Moments and Estimation

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 Predictions on the Whole Distribution



Model Predictions on the Whole Distribution



Quantitative Analysis

Quantitative Analysis: Plan

Decompose the contributions

- market-based v.s. performance-based incentives

Work on contagion effect of corporate governance

- less entrenchment (lower α) v.s. better monitoring (lower c)

And more? ...

Conclusion

Summary

- Executives are motivated by `performance-based incentive` and `market-based incentive`.
- `Market-based incentive` are smaller in larger firms. So 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 incentive

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

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

tdc1: total compensation

delta: dollar-percentage incentive

Company	Market Cap millions	tdc1 000's	delta 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	1106.8351
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