Why do Larger Firms Pay Executives 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 competitionfor 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 pay (bonus, stocks, options, etc.)
30%		70%

- Performance-based incentives:

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

- Firm size premium in performance-based incentives

  delta increases in firm size,

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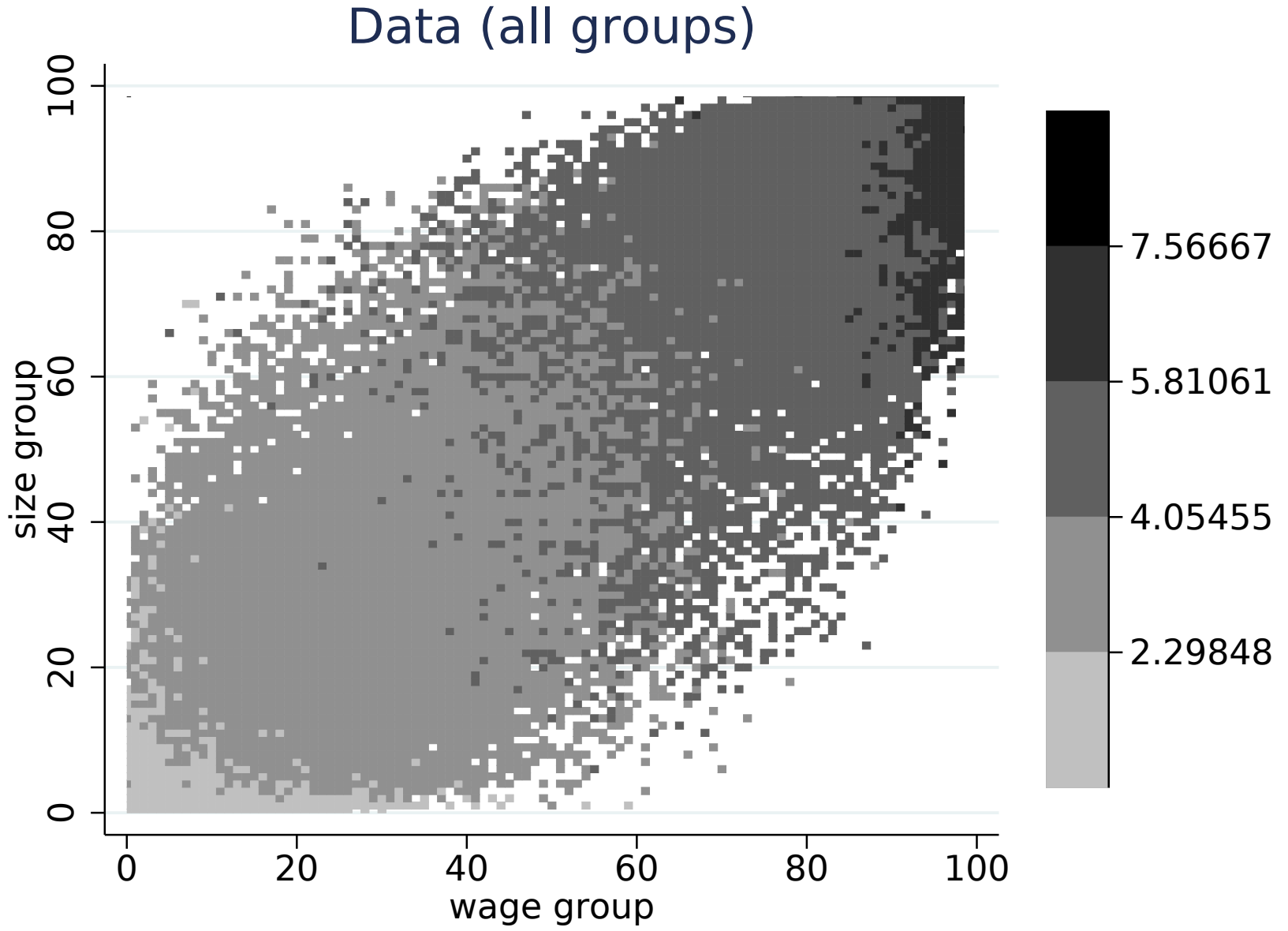
- Firm size premium in performance-based incentives

  delta increases in firm size, controlling for total compensation

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 × 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 compensation.*
- 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 compensation.*
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Research Questions:

- How does the labor market interact with contract incentives?
- Why do larger firms pay more for performance?

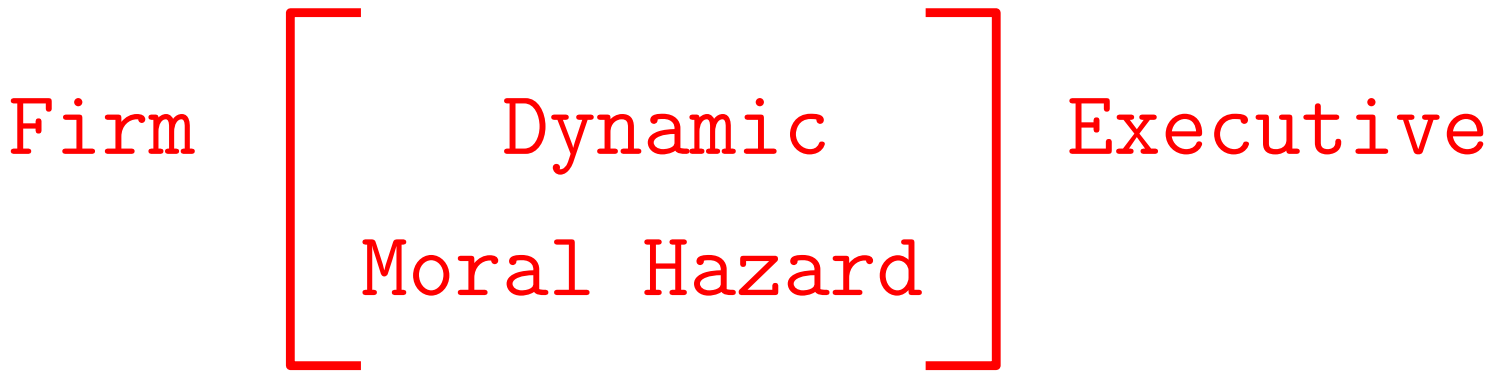
What do I do?

1. Modeling: executive labor market and contract incentives
   - how do career concerns and performance-based incentives interact
   - firm size premium in performance-based incentives

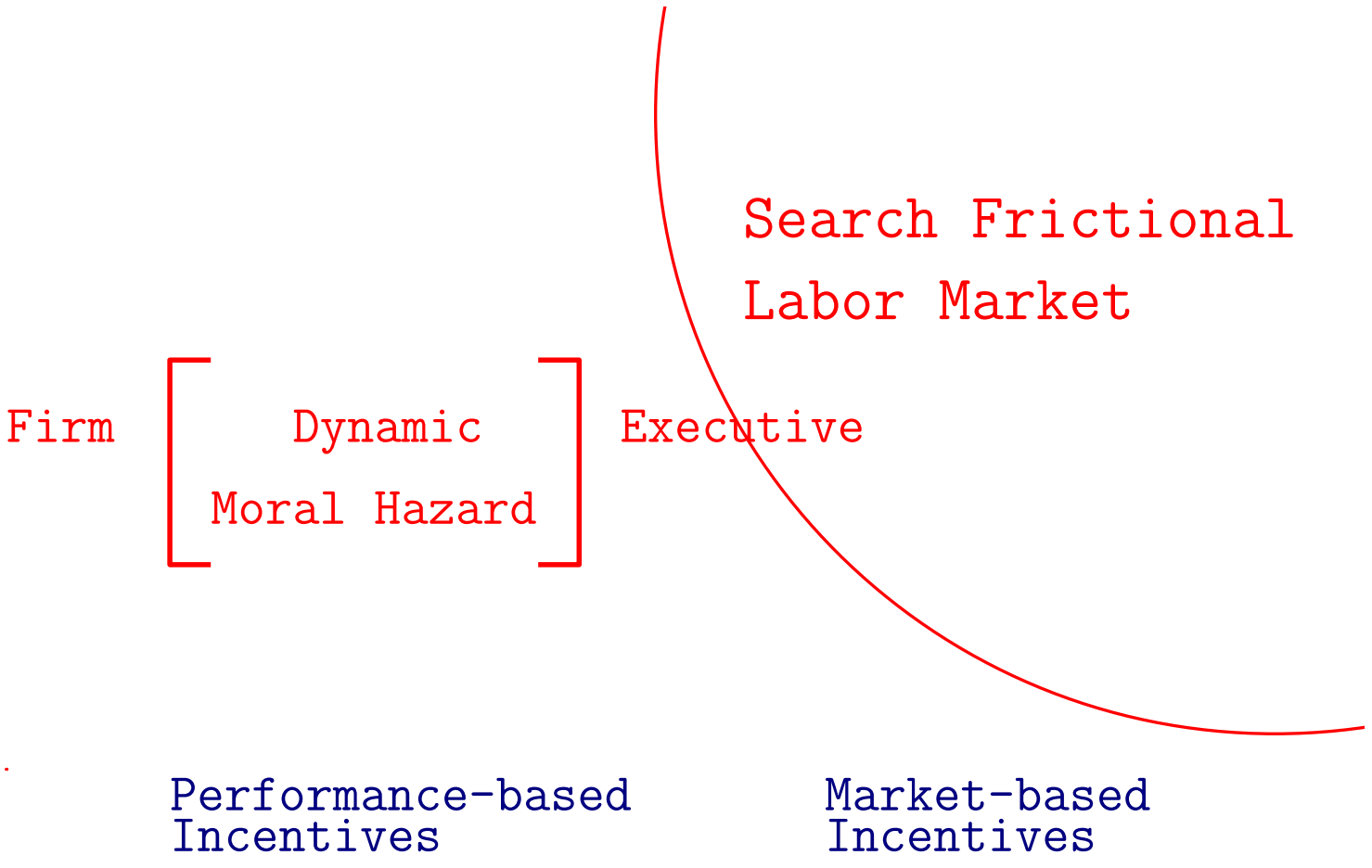
2. Estimation: take the model to US executives data (ExecuComp)

3. Evaluation: work on counter-factuals
   - regulations on executive compensation
   - spillover effect of corporate governance on executive compensation

Key Elements in the Model



Key Elements in the Model



Key Mechanism in the Model

Market competition generates incentives

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

Market-based incentives are weaker in larger firms

- market competition gives rise to higher expected pay
- especially higher for executives in larges firms because they can make use of current firm to negotiate better offers
- by diminishing marginal utility, market-based incentives are 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 poor 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 pay

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

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

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

- consider the match between one firm and one executive with production

$$f(s, z) = \alpha s z,$$

where s is firm size

Market Competition

Another firm with size s' poaches the executive

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

Bertrand competition

- since $s' > s$, the executive transits to s' and gets a pay of αsz

Contracting Problem

The firm maximizes

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

subject to

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

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

Note: period 1 in red, period 2 in blue.

Optimal Contract

The optimal contract follows

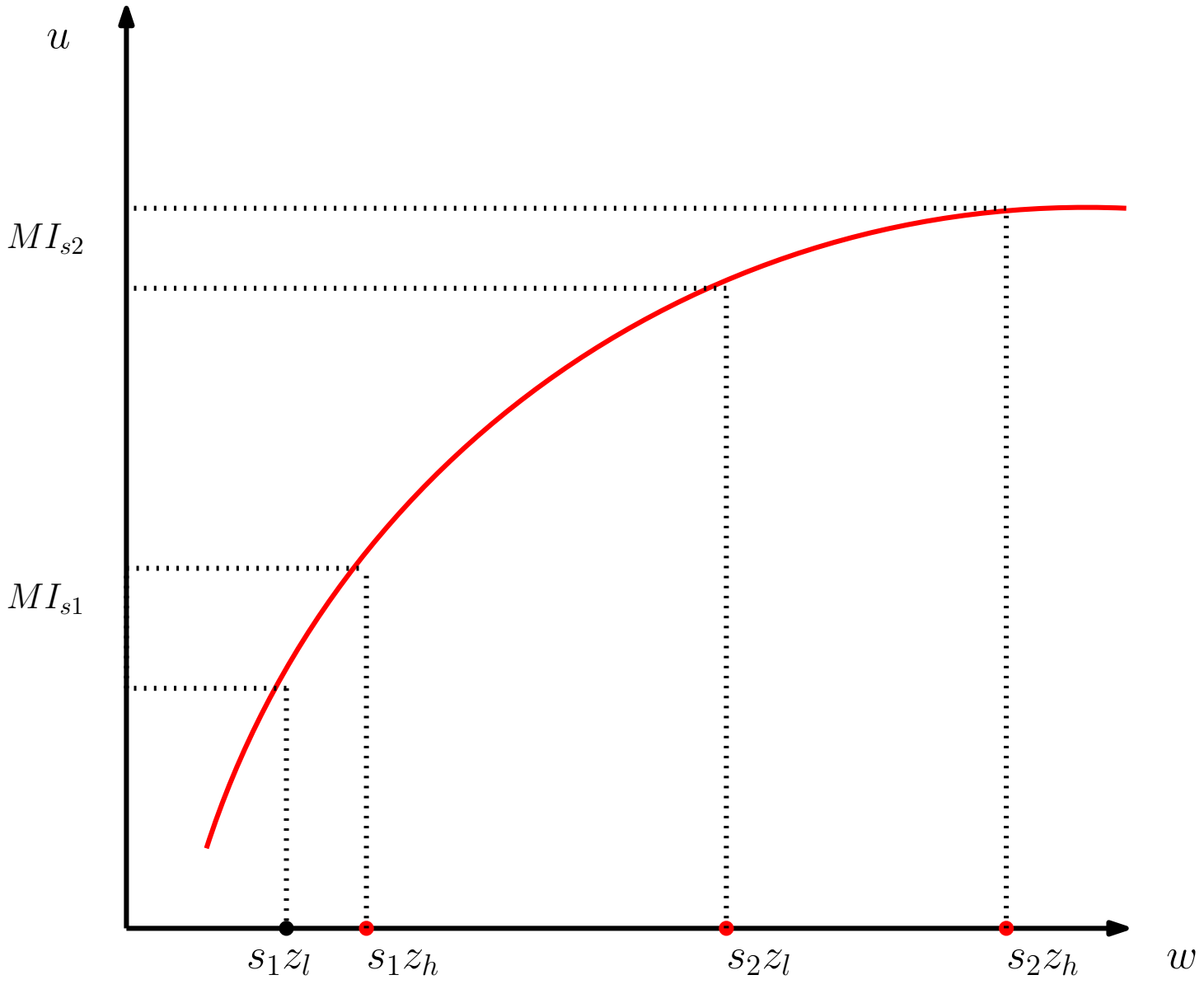
$$w(z) = w_2(z) = \lambda + \mu(1 - g(z)),$$

where μ determines the pay-for-performance incentive

$$\underbrace{\int_z \Big[u(w(z))s + \beta(1-\lambda)u(w_2(z))\Big](1-g(z))d\Gamma(z)}_{\text{Performance-based Incentives}}$$
$$+ \underbrace{\int_z \Big[\beta\lambda u(\alpha sz)\Big](1-g(z)d\Gamma(z)}_{\text{Market-based Incentives}} \geq c \qquad \text{(IC)}$$

How binding IC constraint is depends on how large market-based incentives are.

Compare market-based incentives between $s_1 < s_2$



Market-based incentives decrease in firm size

Proposition

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

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

Intuition

Market competition raises the overall compensation level making the executive less sensitive to market incentives due to diminishing marginal utility

Towards a Dynamic Model

Why do we need a dynamic model?

- Match the data.
  Two-period model is too simple to generate the moments.
- Job ladder equilibrium effect.
  The maximum value a firm is willing to bid depends on the market competition that it faces, in particular the bids of firms higher on the job ladder.
- Study the contagion effects.
  In the equilibrium, we study the spillover effects of corporate governance in large firms.

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 eq.

Dynamic Model

- dynamic moral hazard
- persistent productivity $\Gamma(z, z')$
- outside firm follows $F(s')$
- spillover effect in the eq.

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 breaks up, job disappears

Firms:

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

Set Up

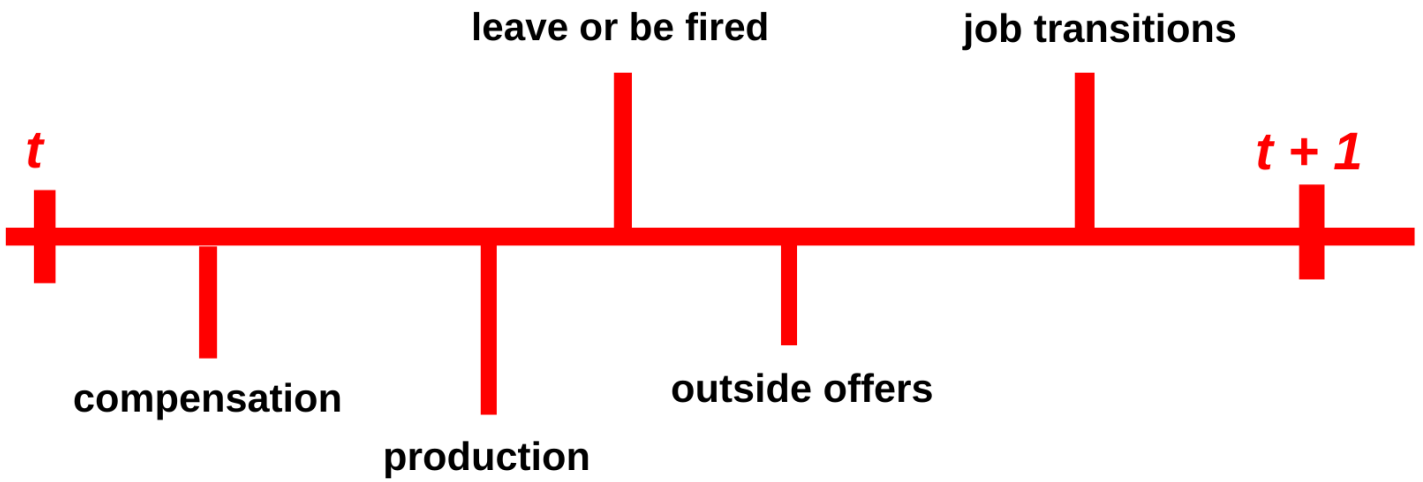
Search Market:

- 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

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

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

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

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

Optimal Contract

The Optimal 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

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

where $W(z')$ 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

$$V = u(w) - c + \tilde{\beta} \sum_{z'} \Bigg[\lambda_1 \sum_{s' \in \mathcal{M}_1} F(s') \overline{W}(z', s) + \lambda_1 \sum_{s' \in \mathcal{M}_2} F(s') \overline{W}(z', s') + \Big(1 - \lambda_1 \sum_{s' \in \mathcal{M}_1 \cup \mathcal{M}_2} F(s')\Big) W(z') \Bigg] \Gamma(z, z'), \qquad (PKC')$$

and the incentive compatibility constraint becomes

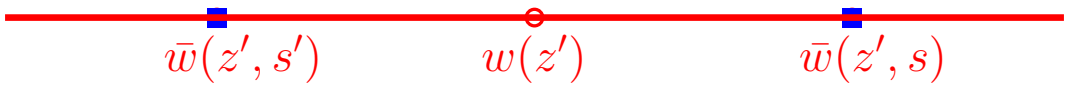
$$\tilde{\beta} \sum_{z'} \Bigg[\lambda_1 \sum_{s' \in \mathcal{M}_1} F(s') \overline{W}(z', s) + \lambda_1 \sum_{s' \in \mathcal{M}_2} \overline{W}(z', s') F(s') + \Big(1 - \lambda_1 \sum_{s' \in \mathcal{M}_1 \cup \mathcal{M}_2} F(s')\Big) W(z') \Bigg] (1 - g(z, z')) \Gamma(z, z') \geq c. \qquad (IC')$$

The Optimal Contract in terms of wage w

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

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

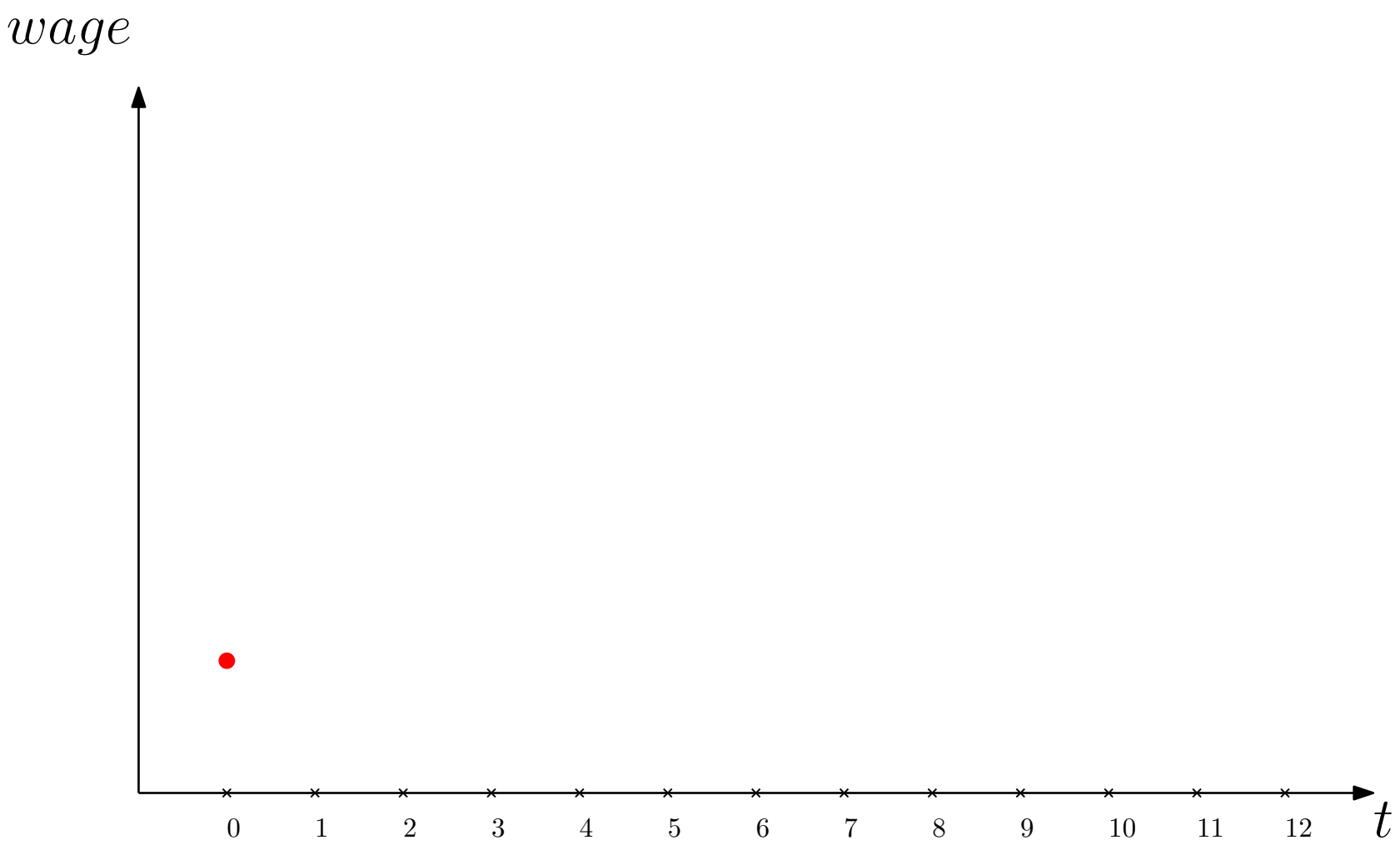
where $w(z') = w(z) + \mu(1 - g(z, z')$.



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

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

Optimal Contract



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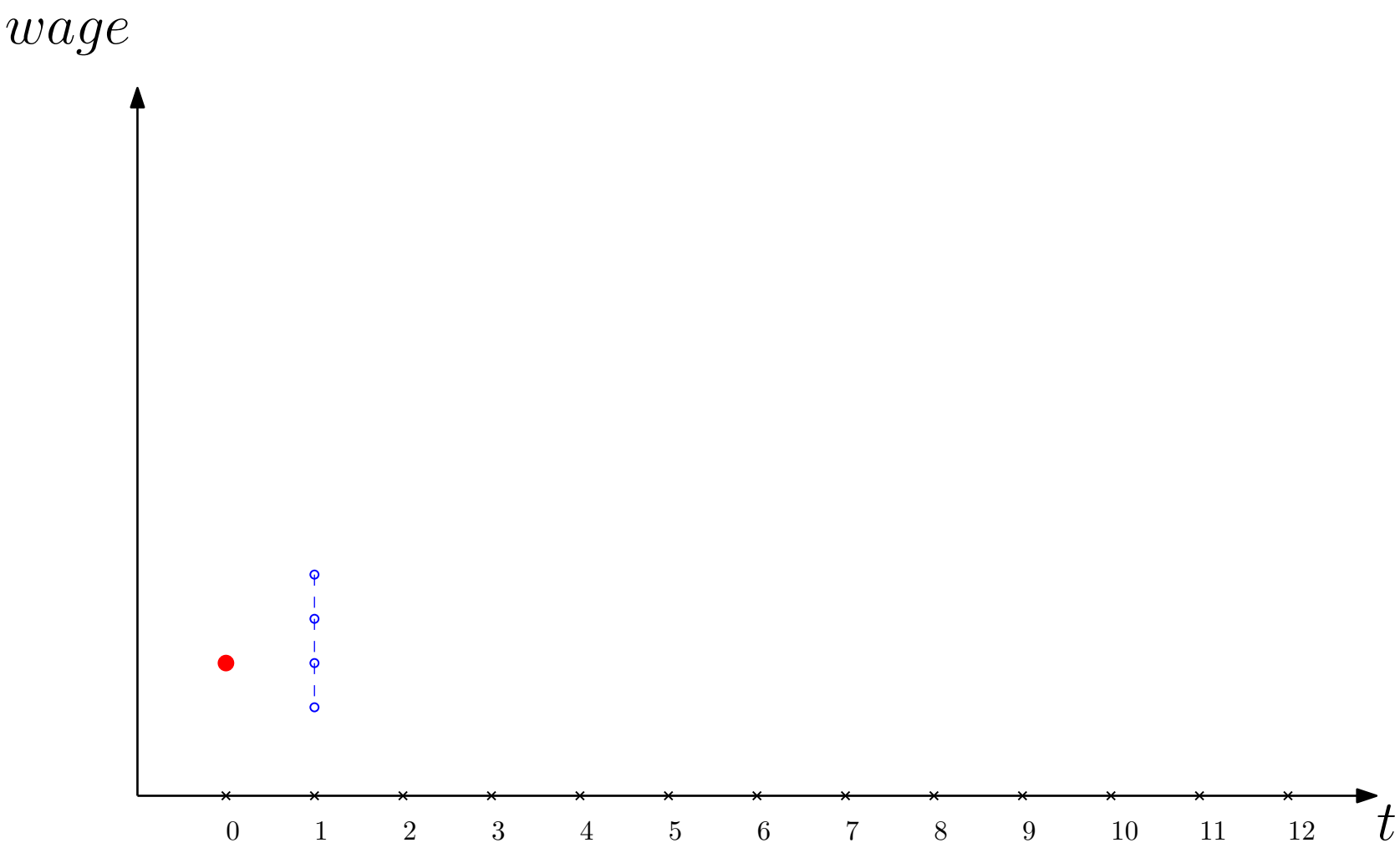

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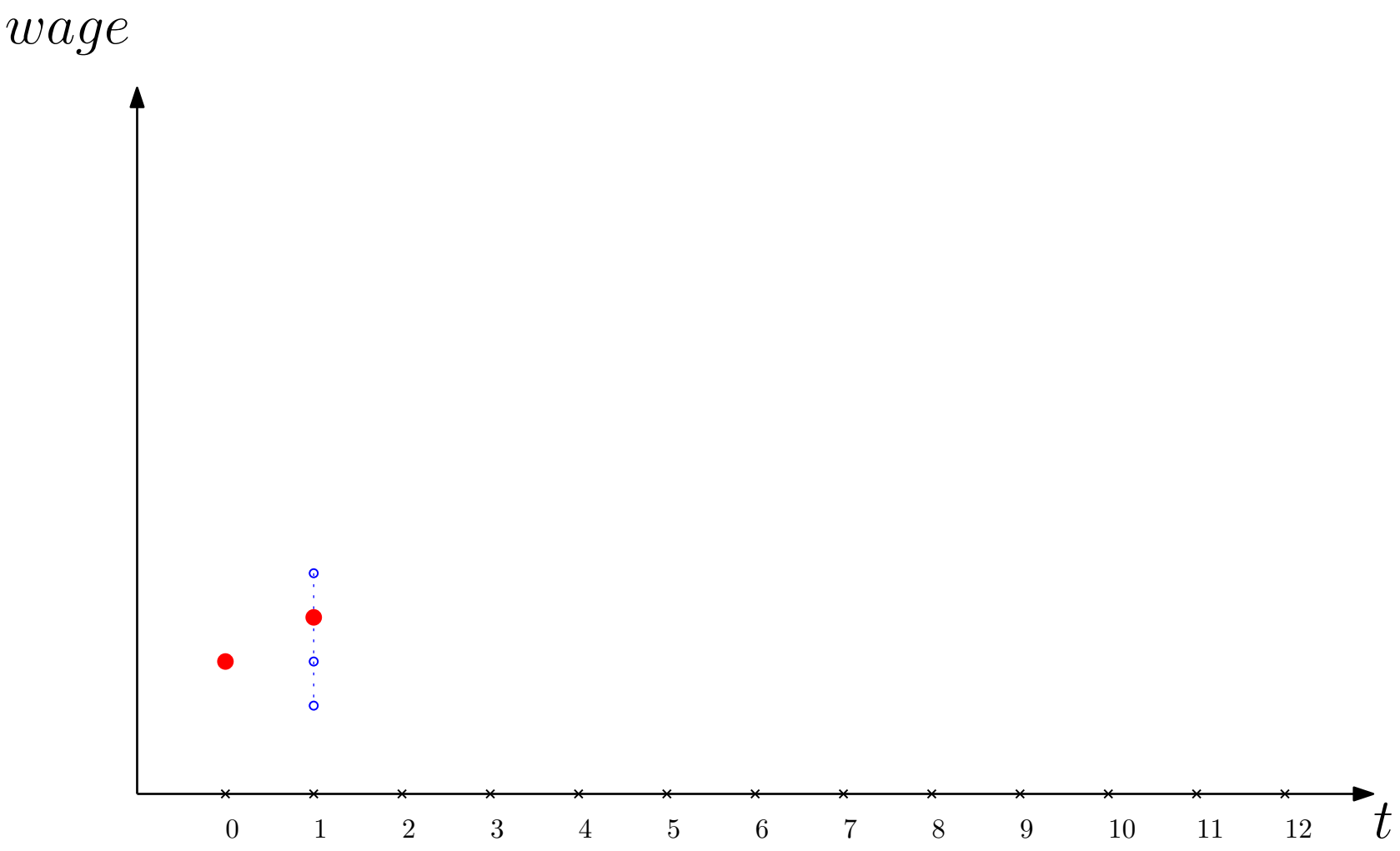

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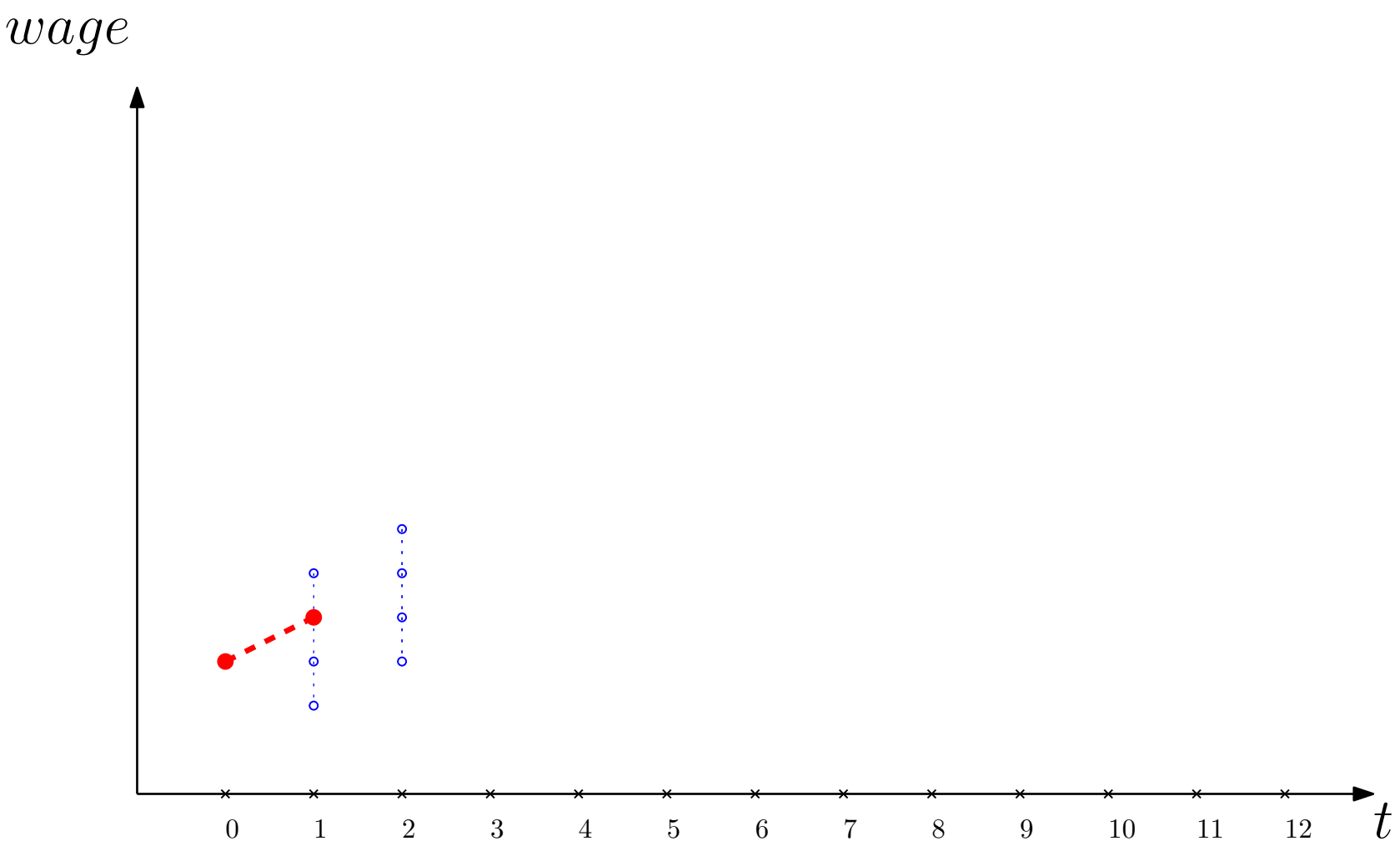

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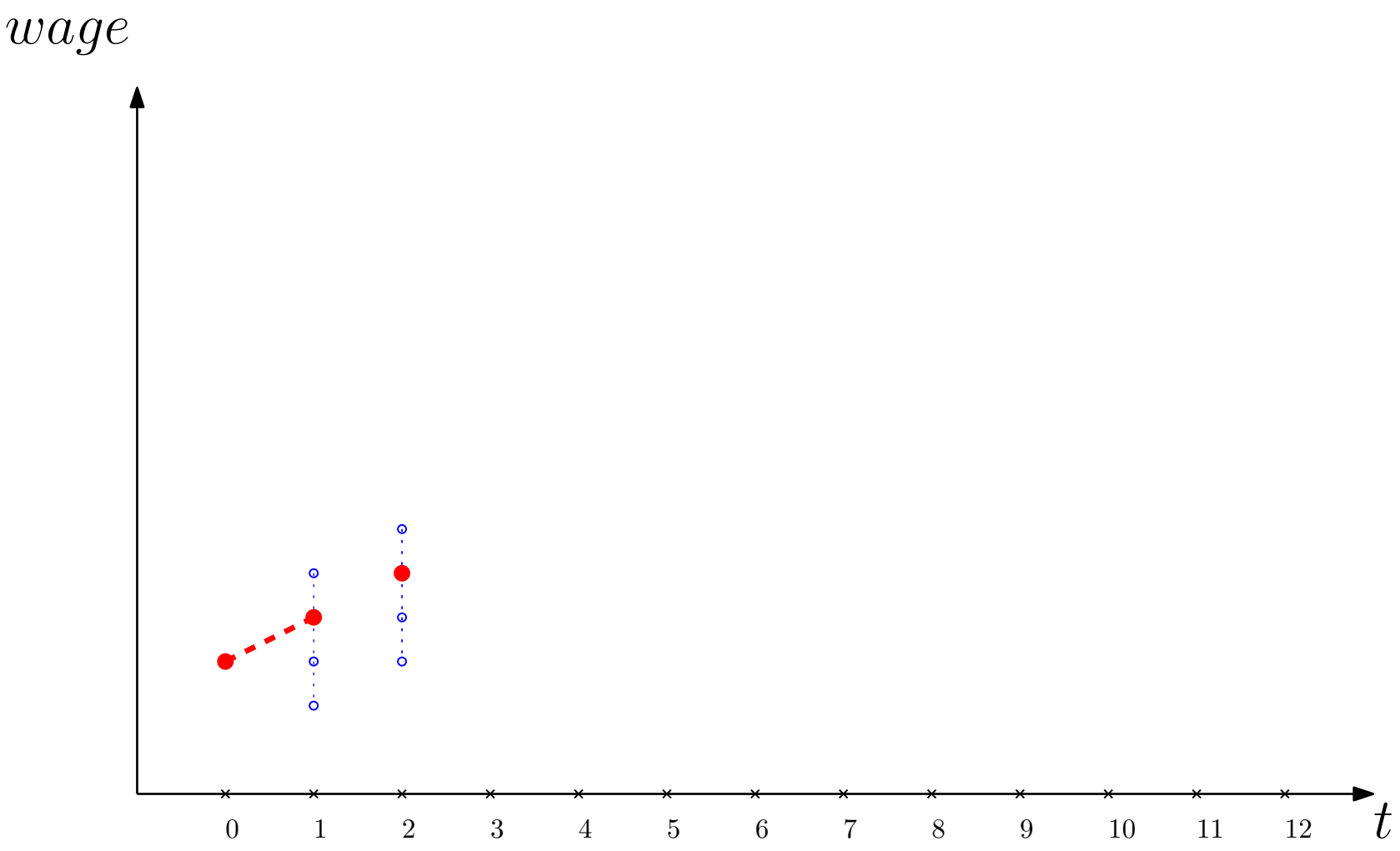

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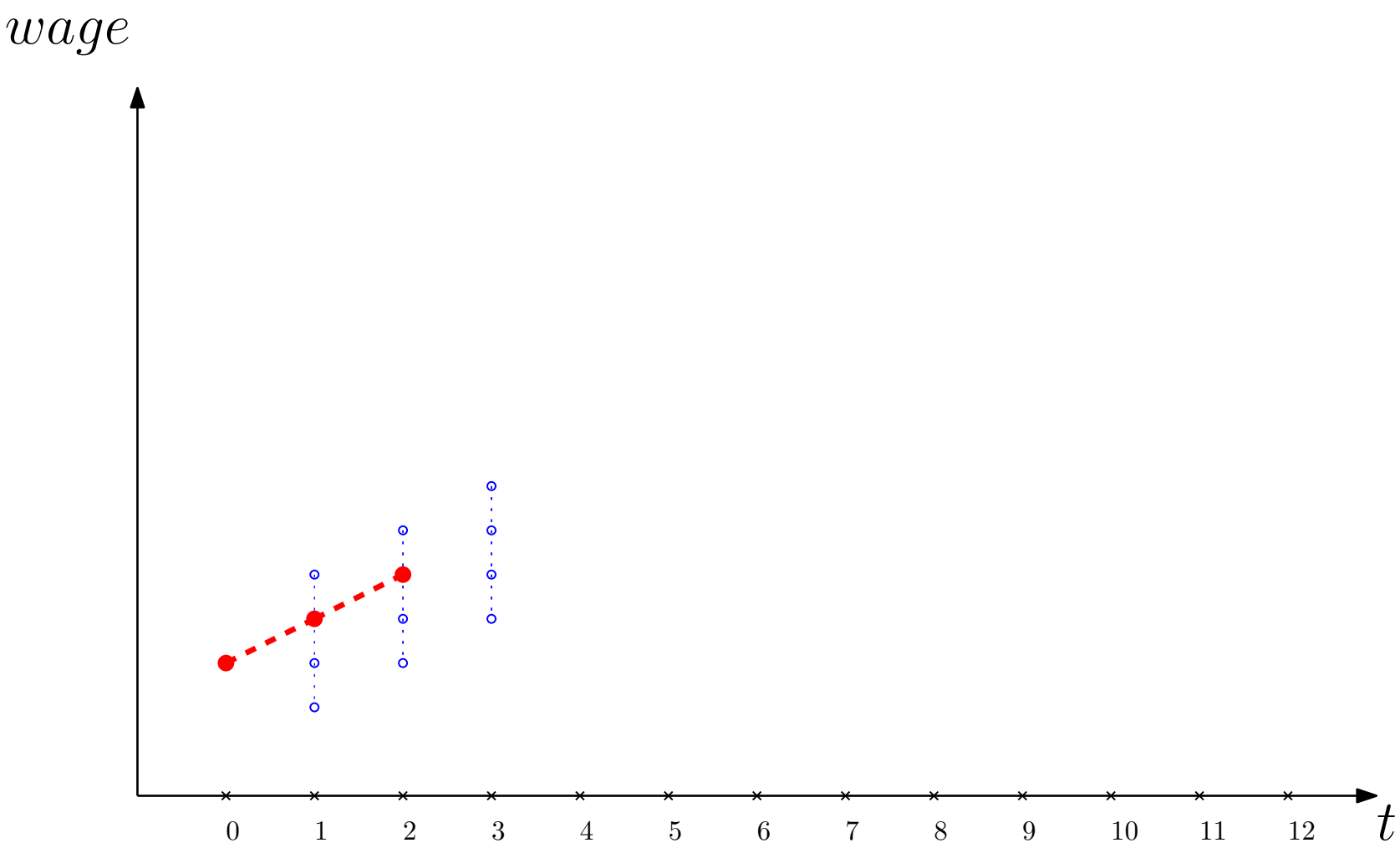

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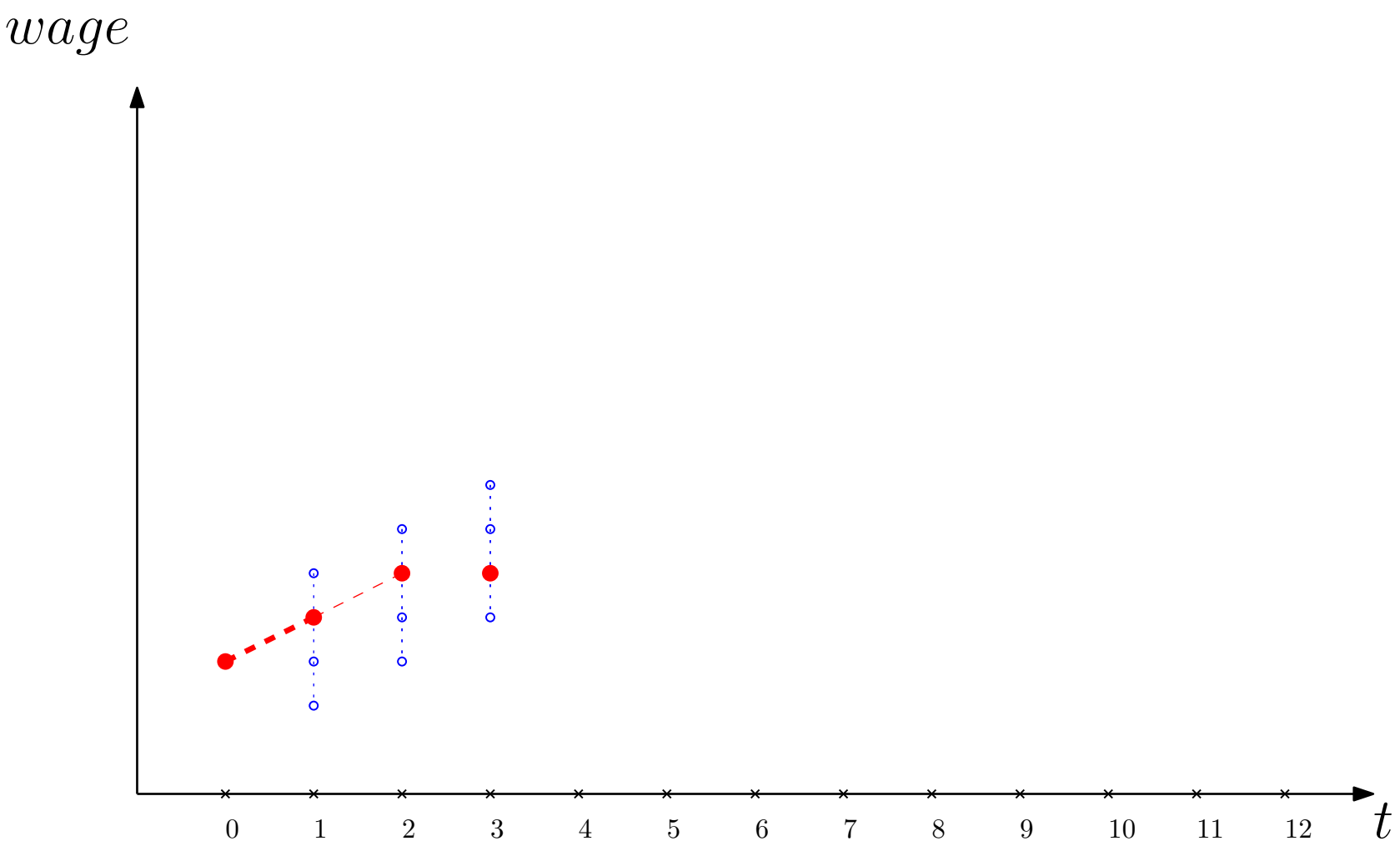

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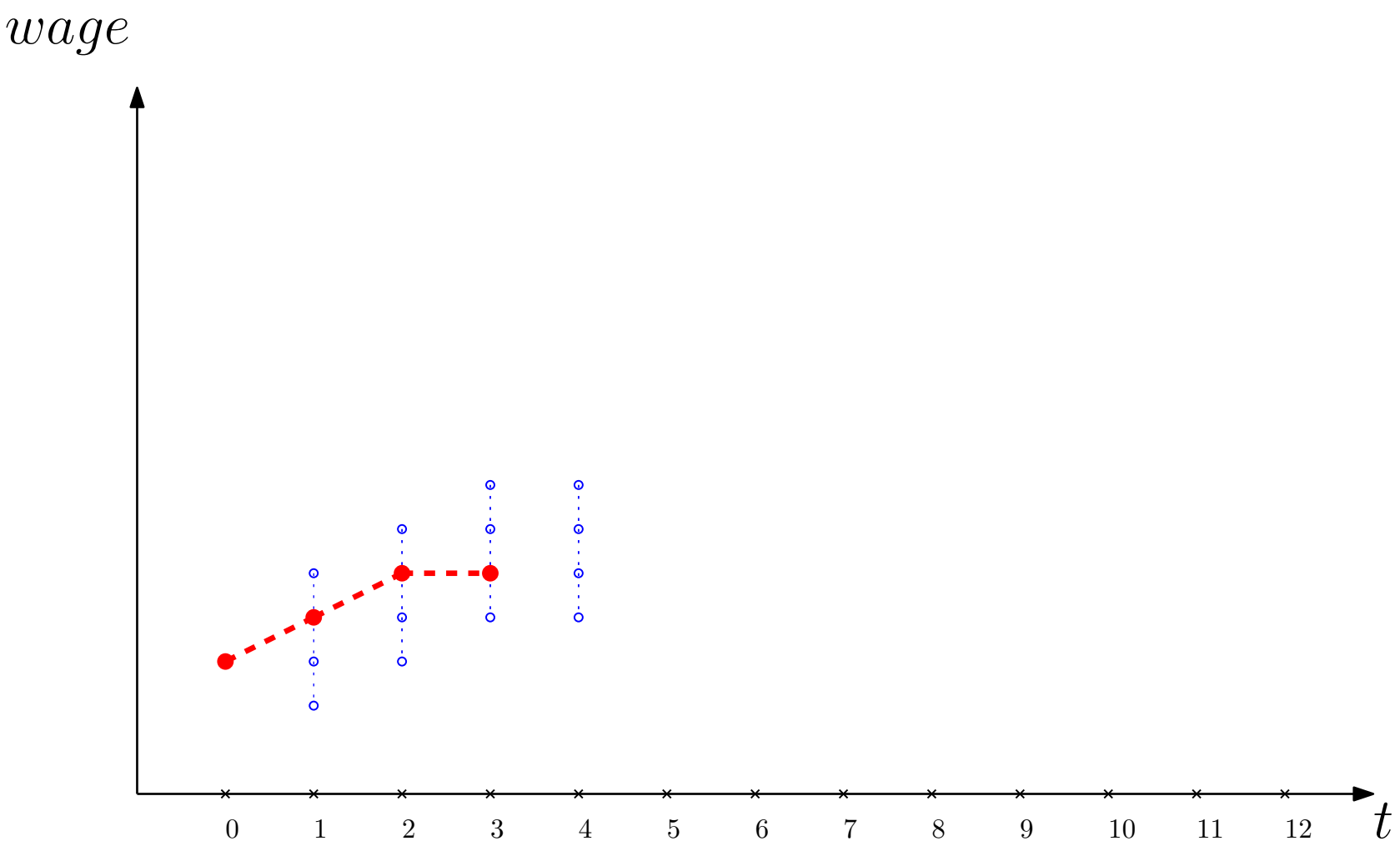

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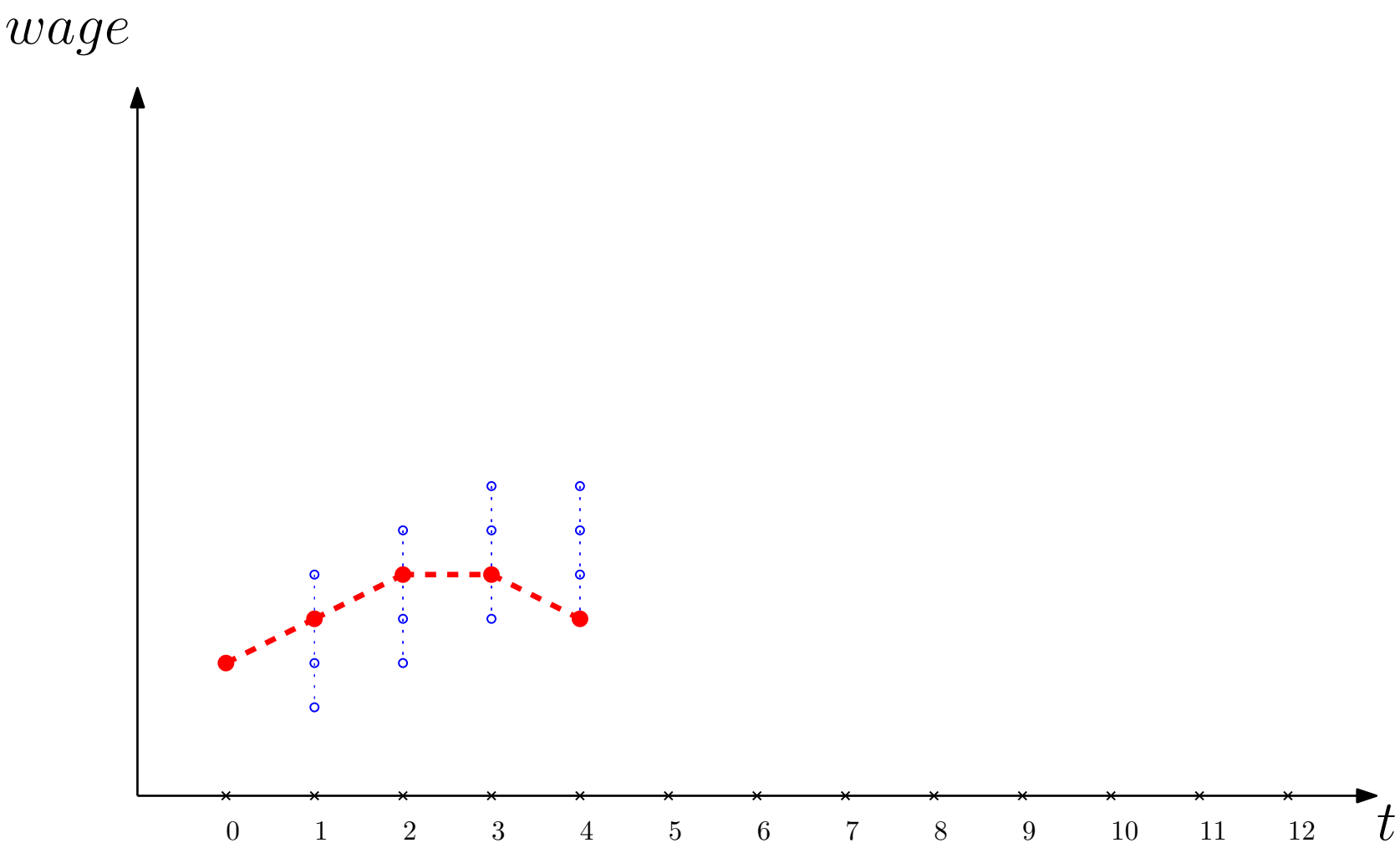

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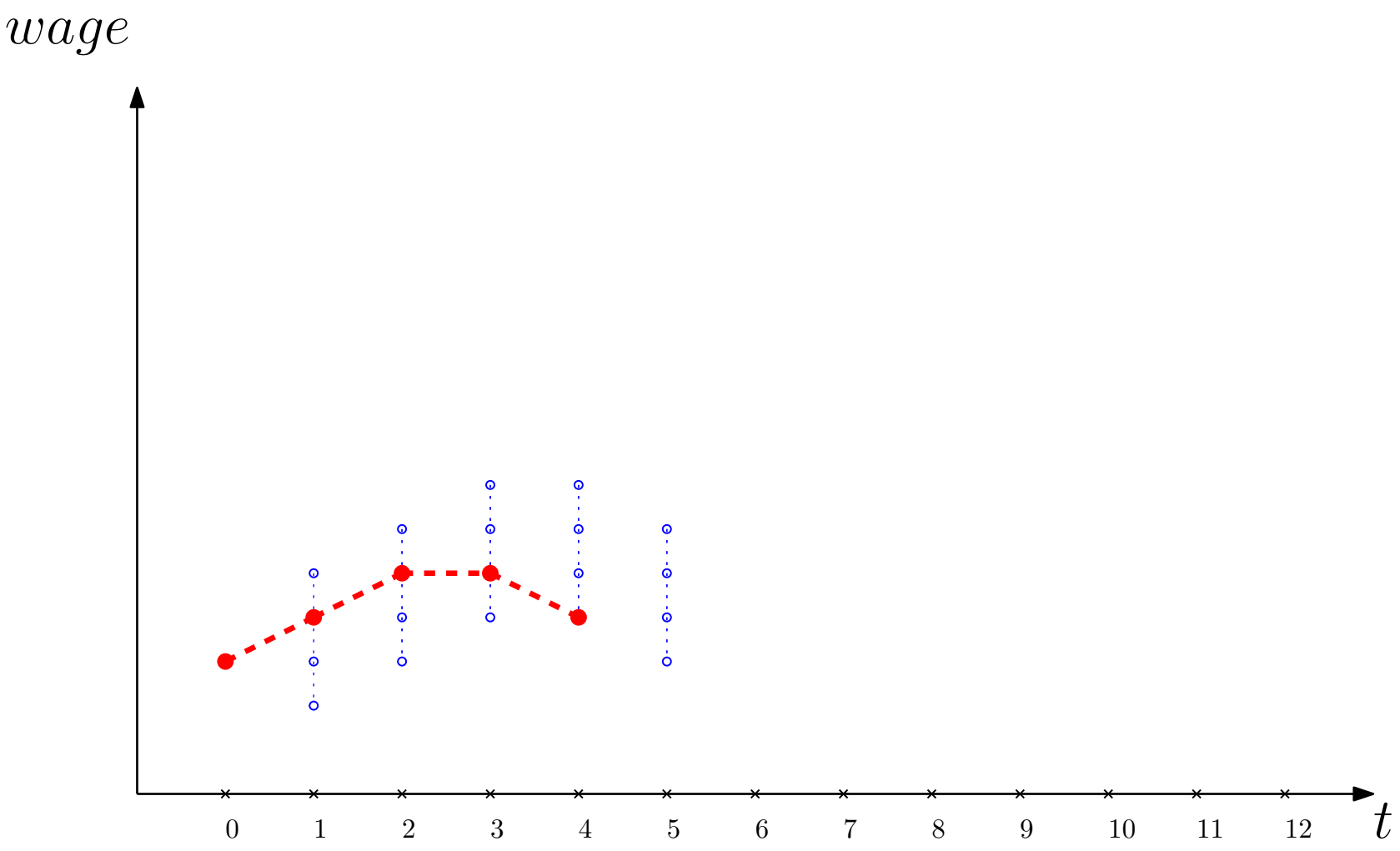

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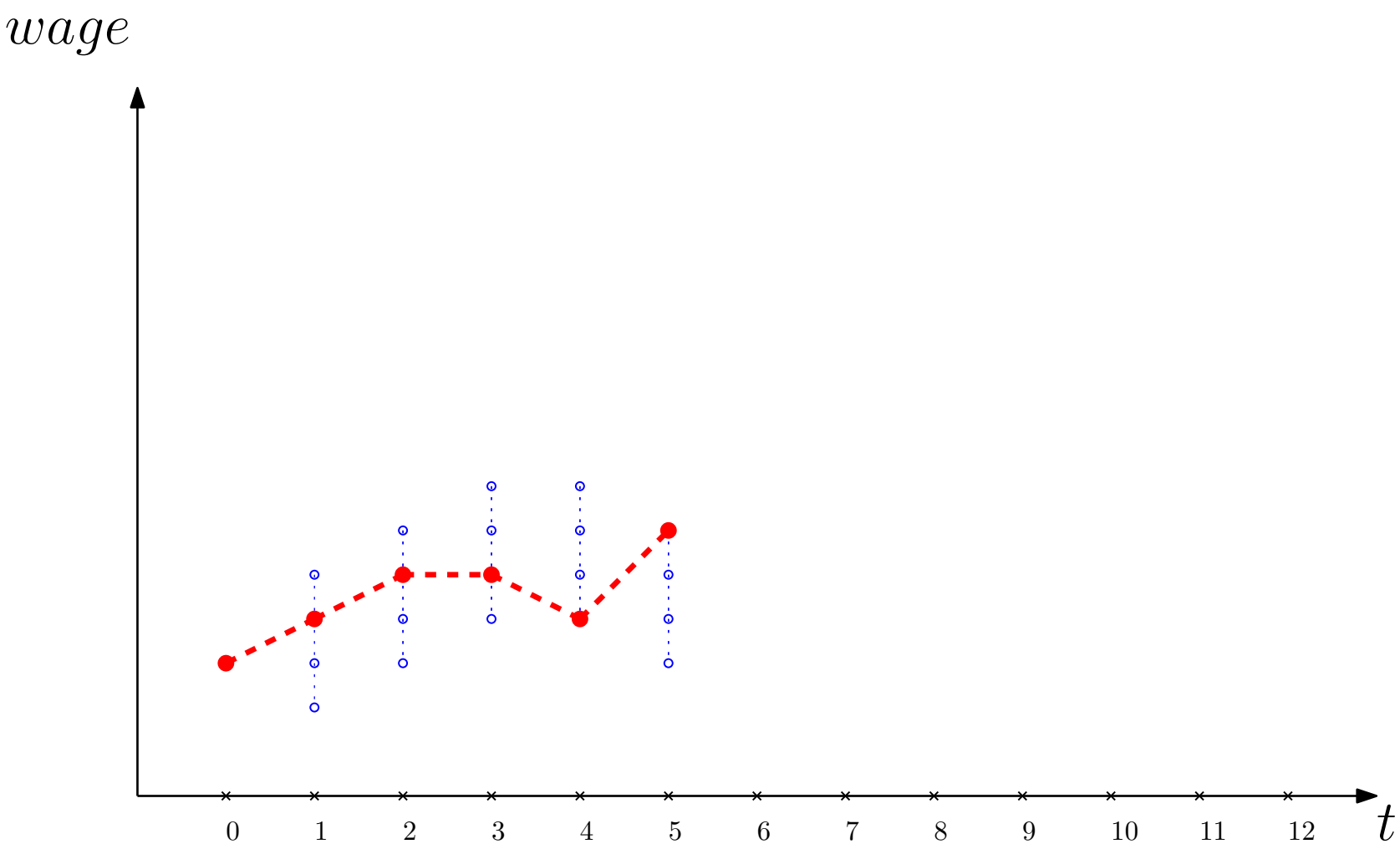

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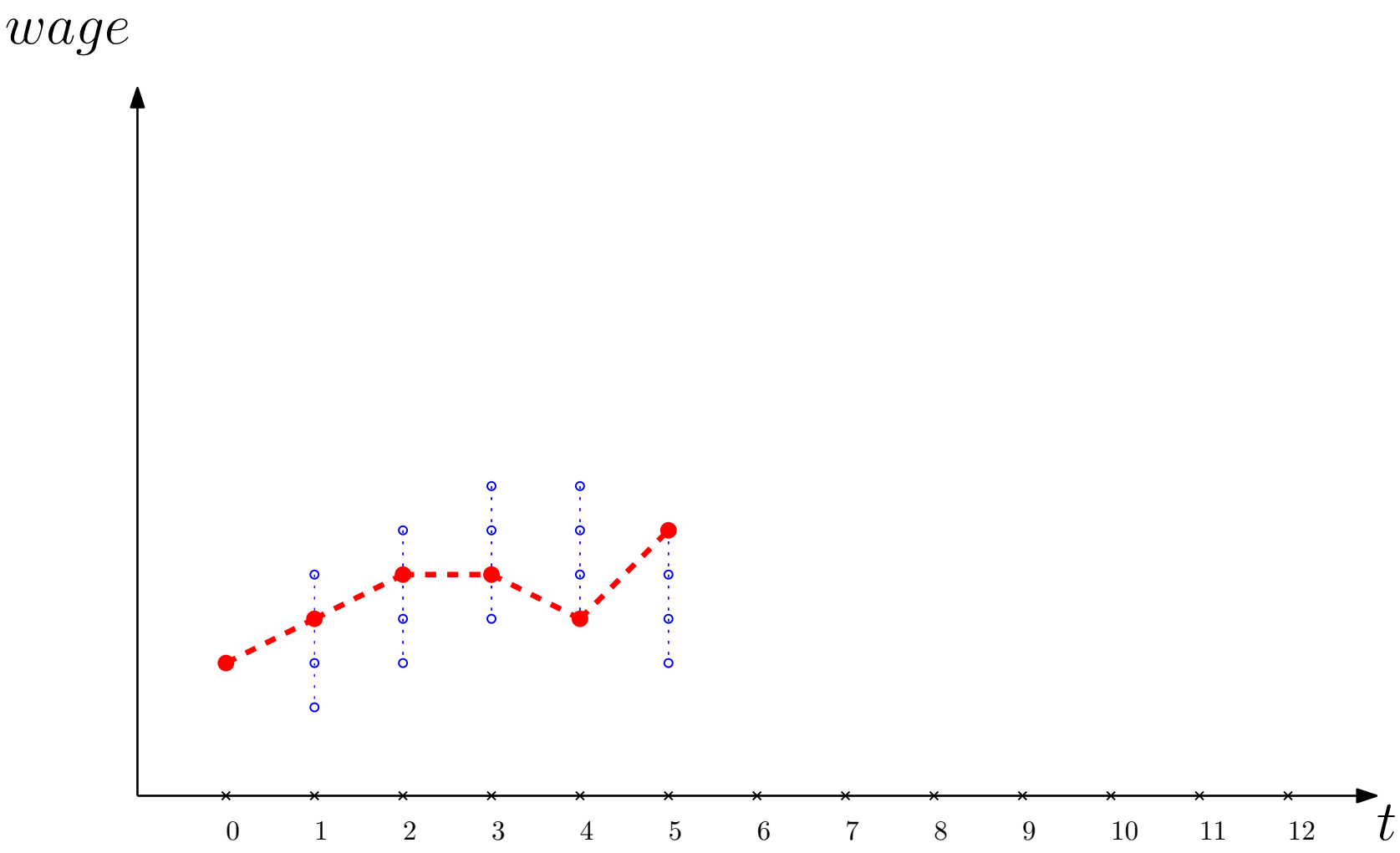

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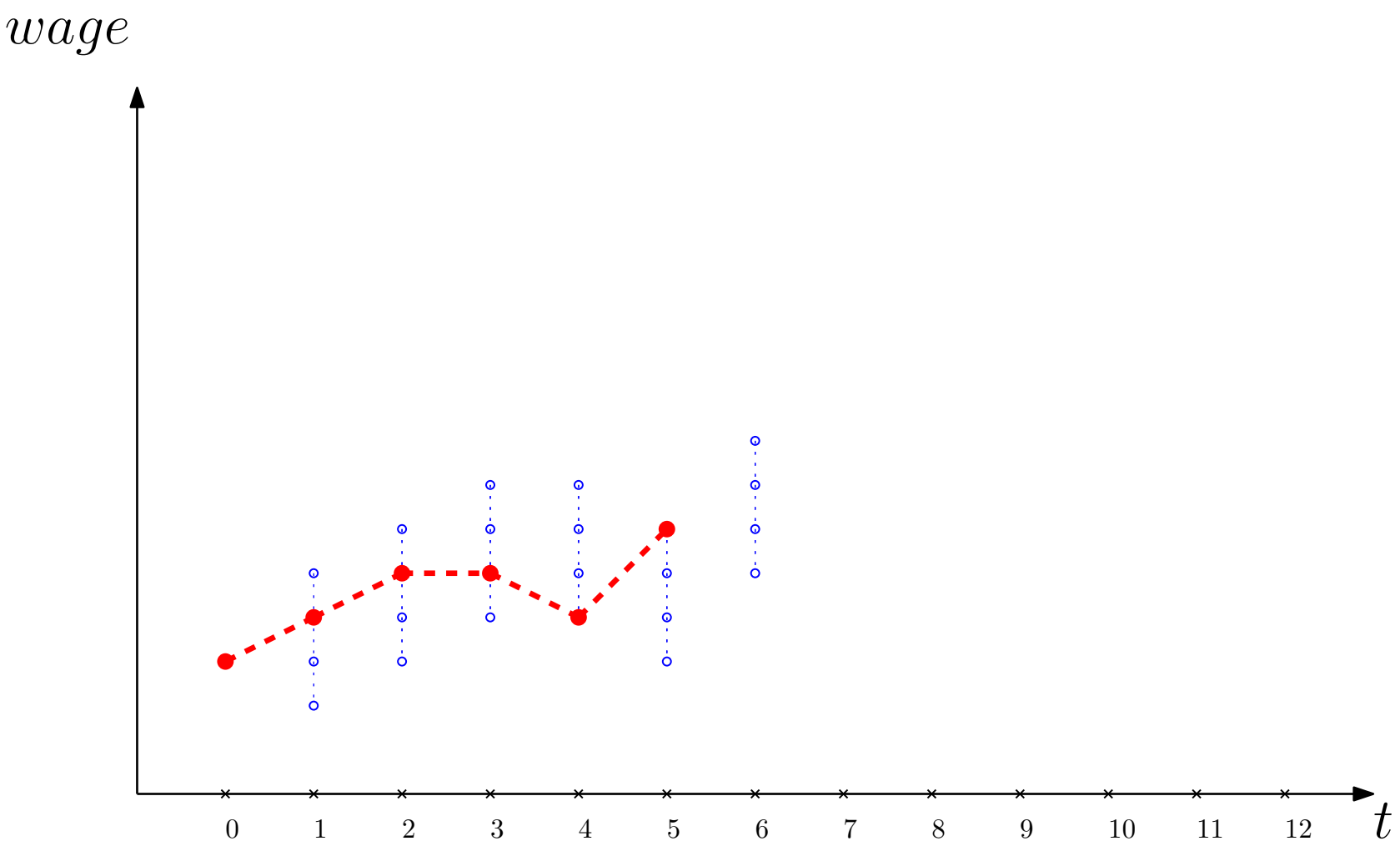

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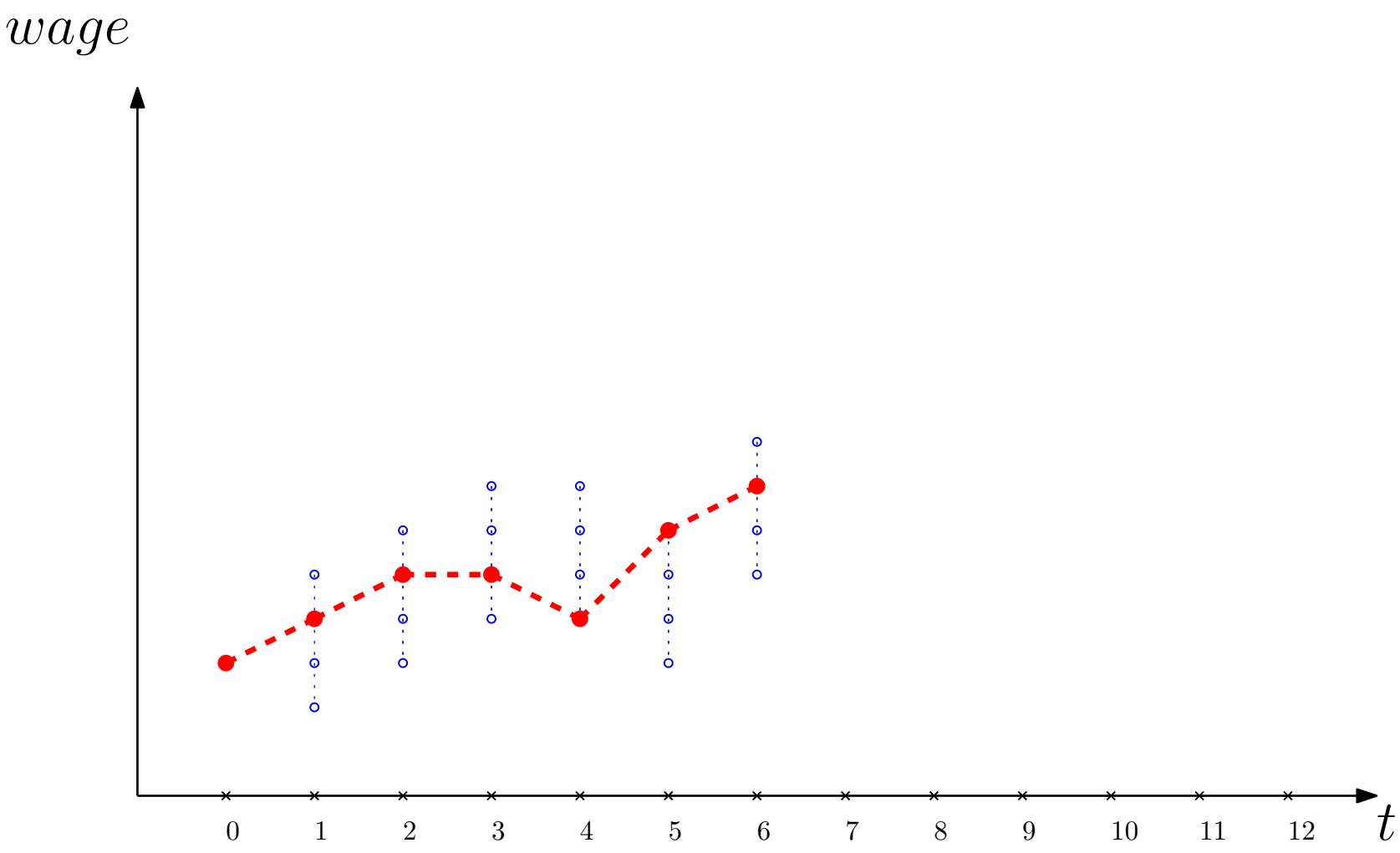

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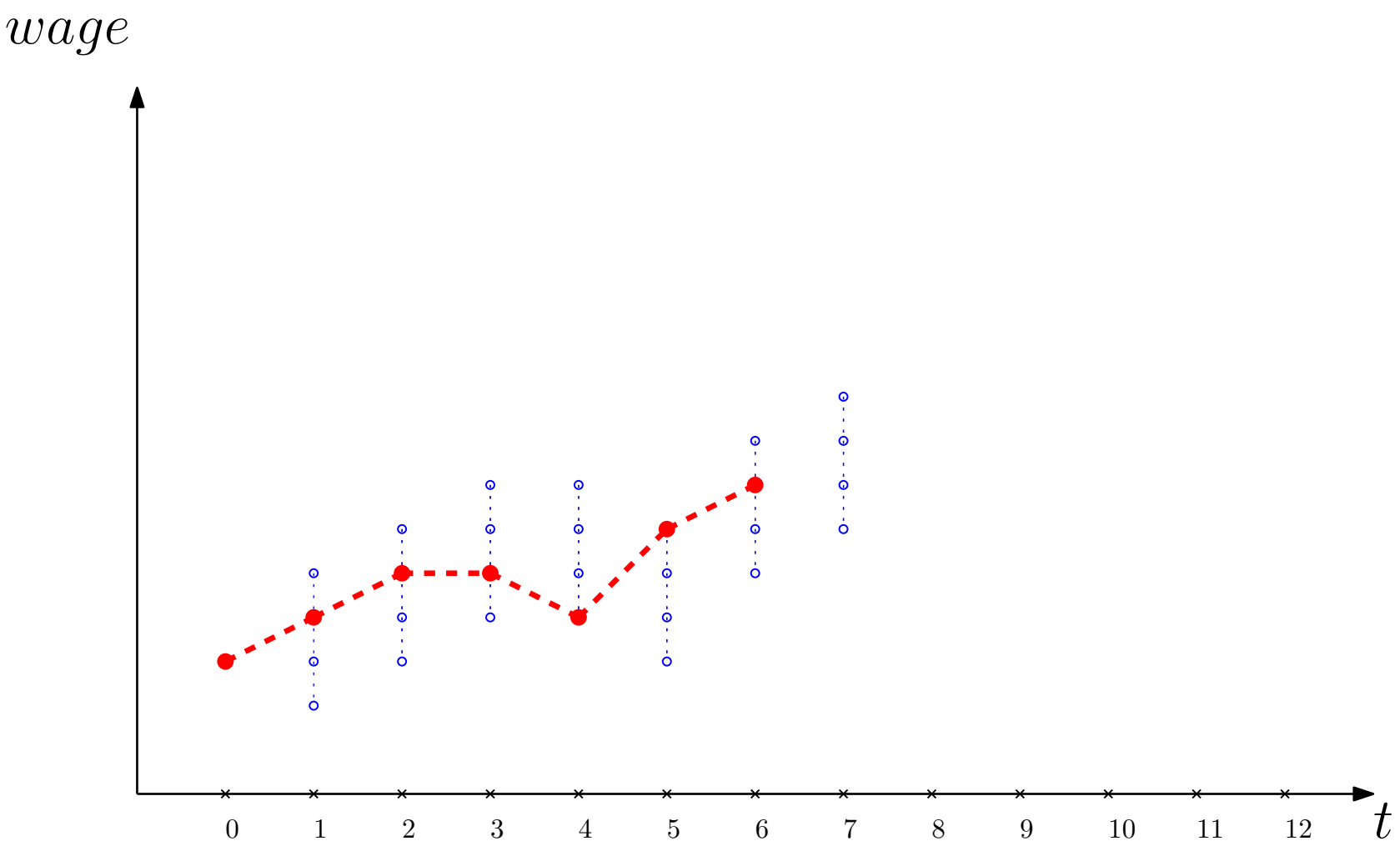

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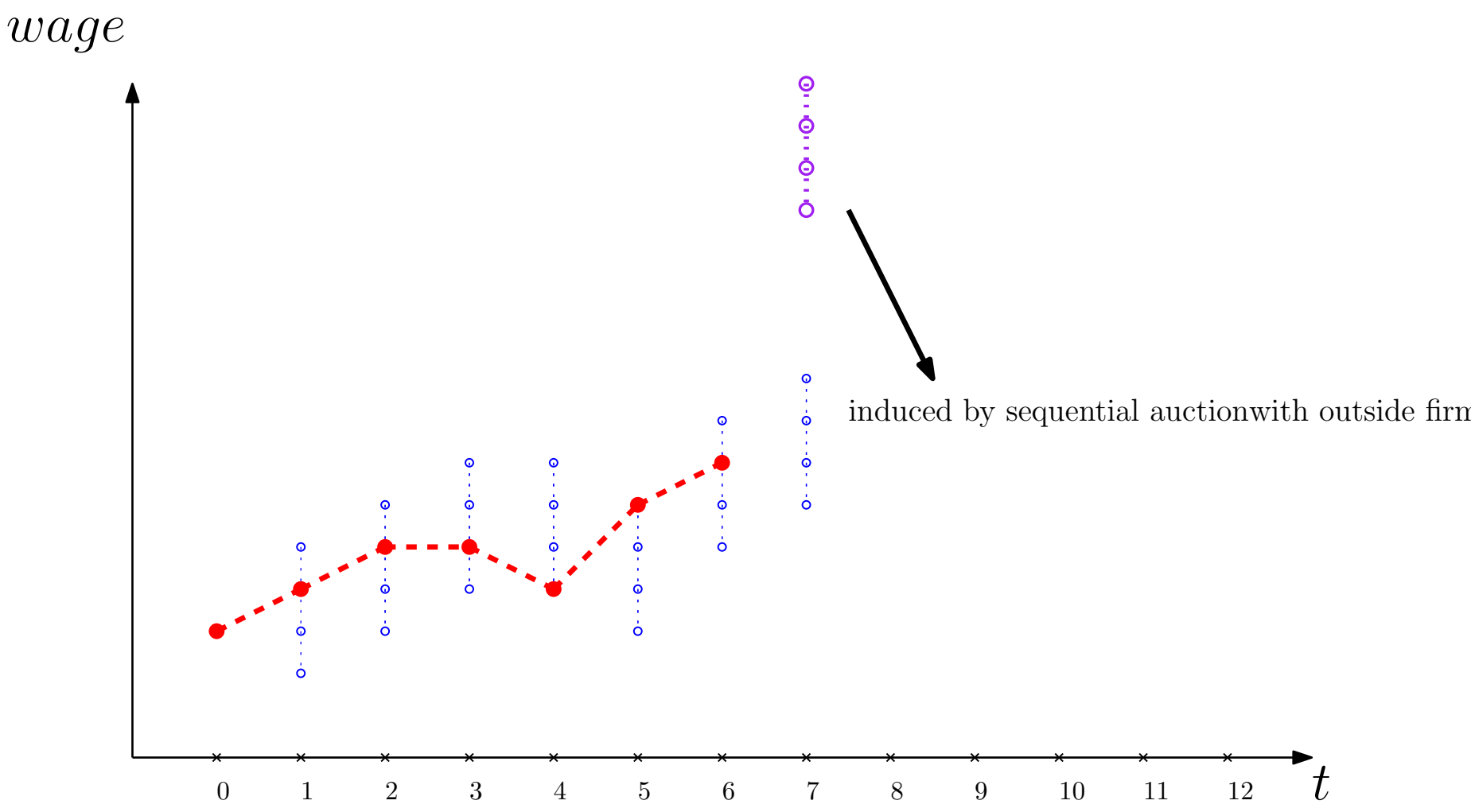

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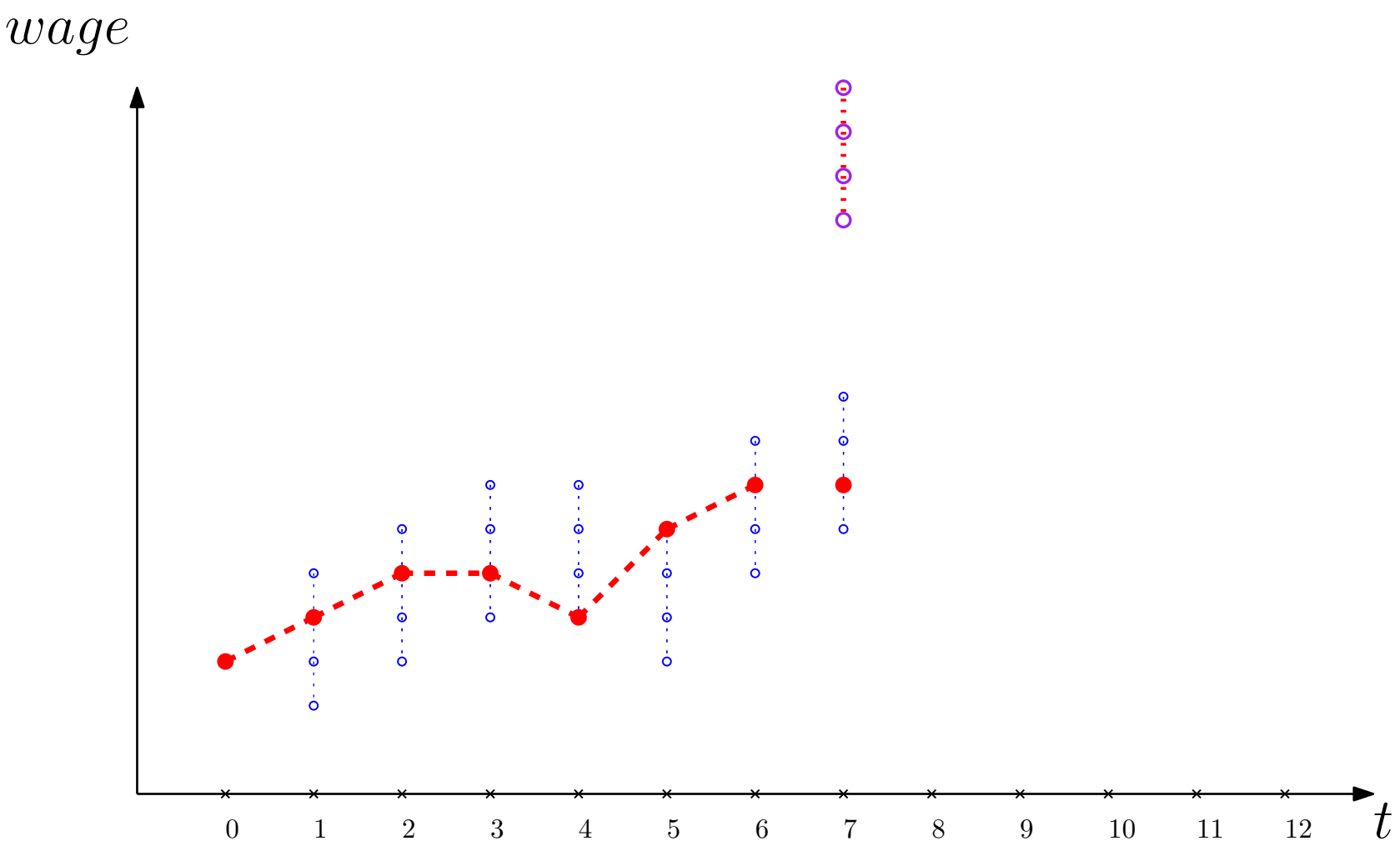

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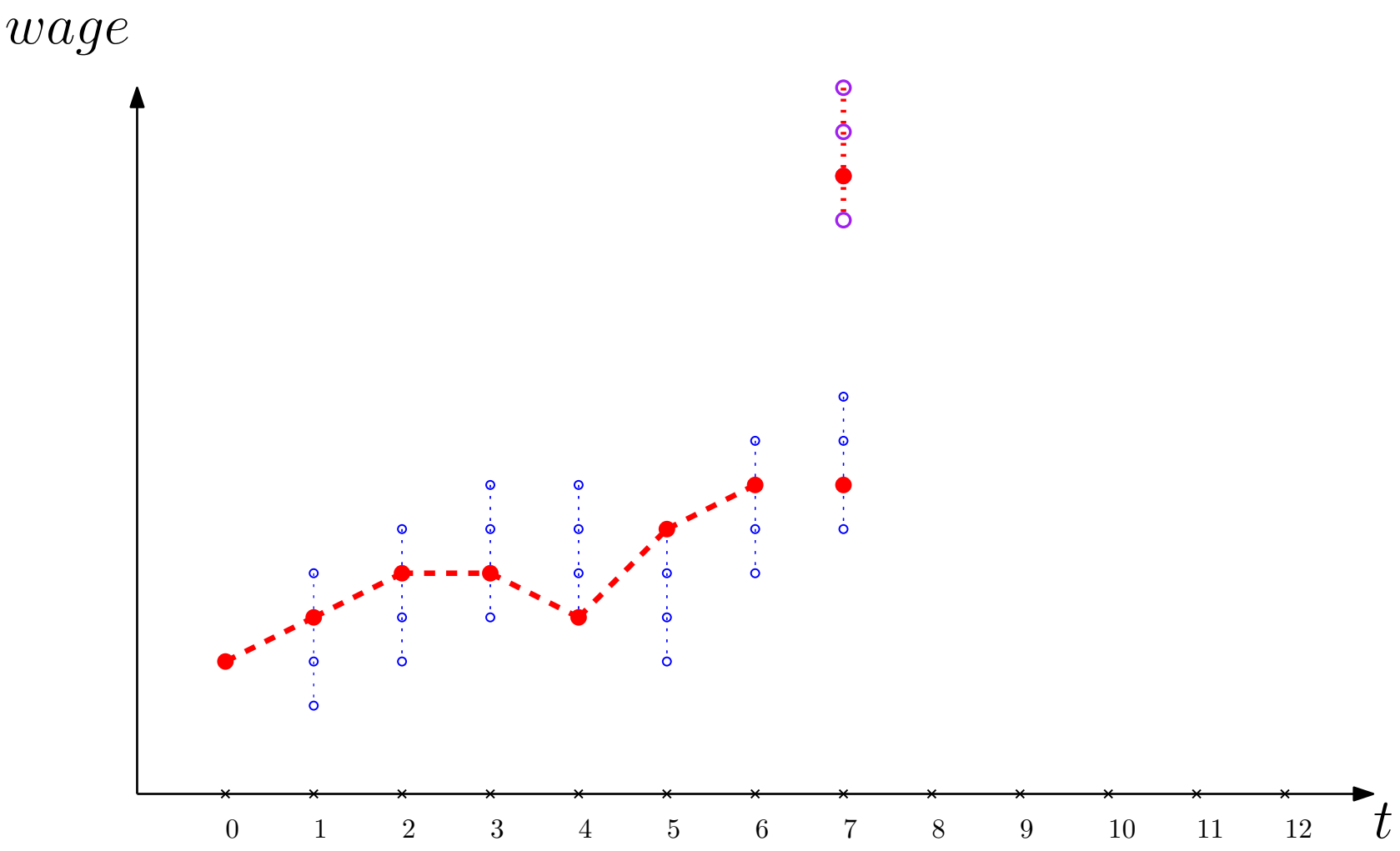

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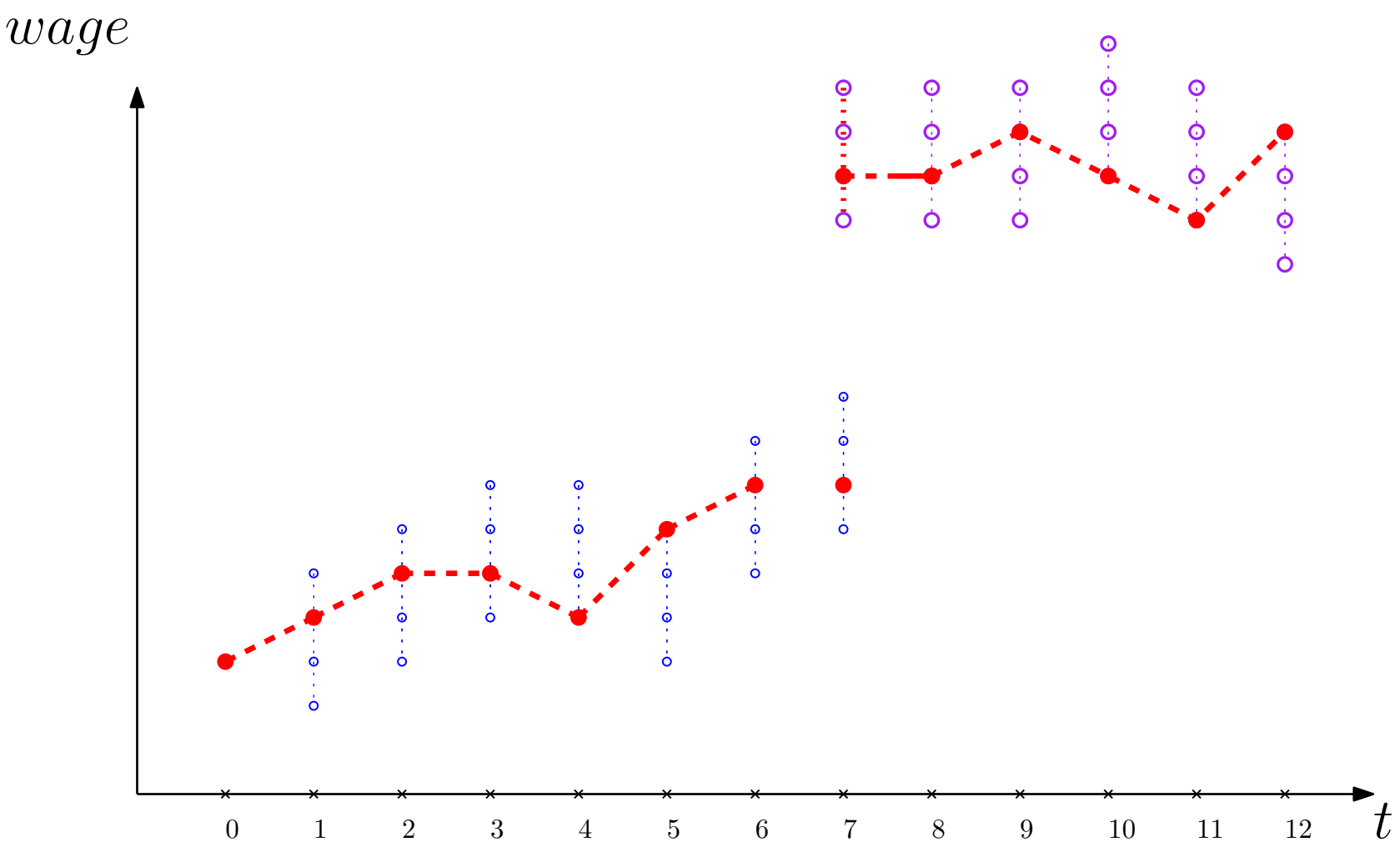

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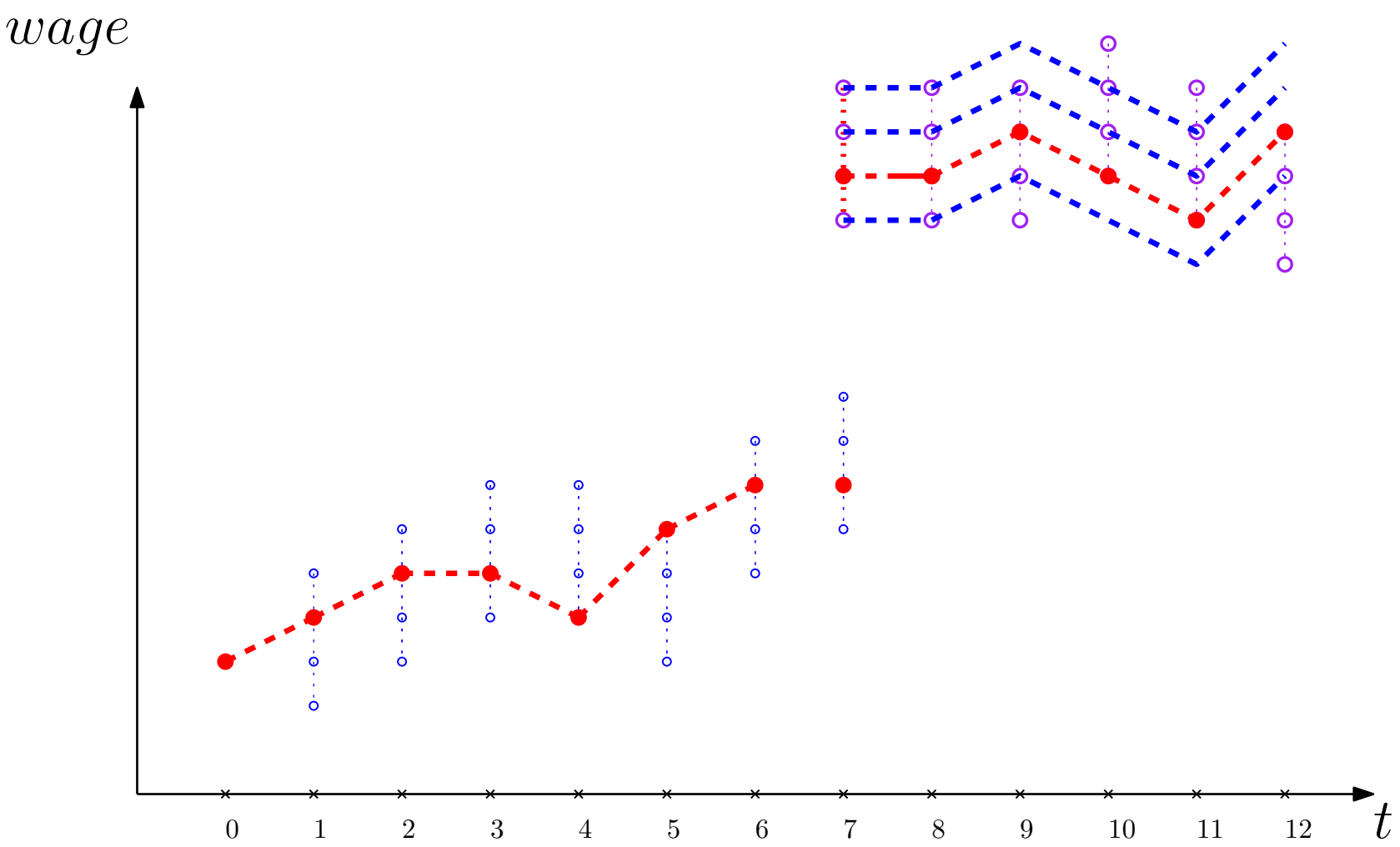
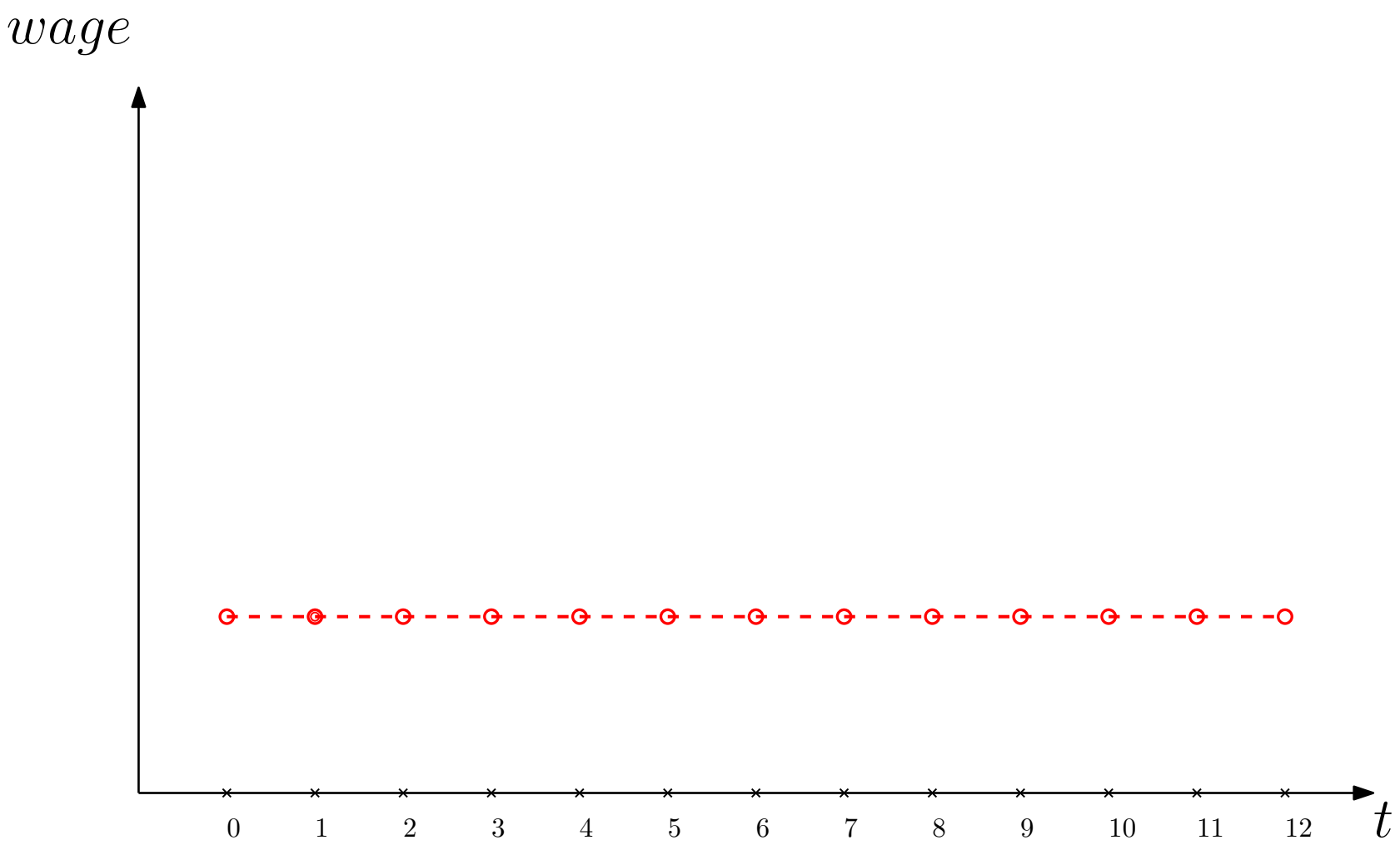
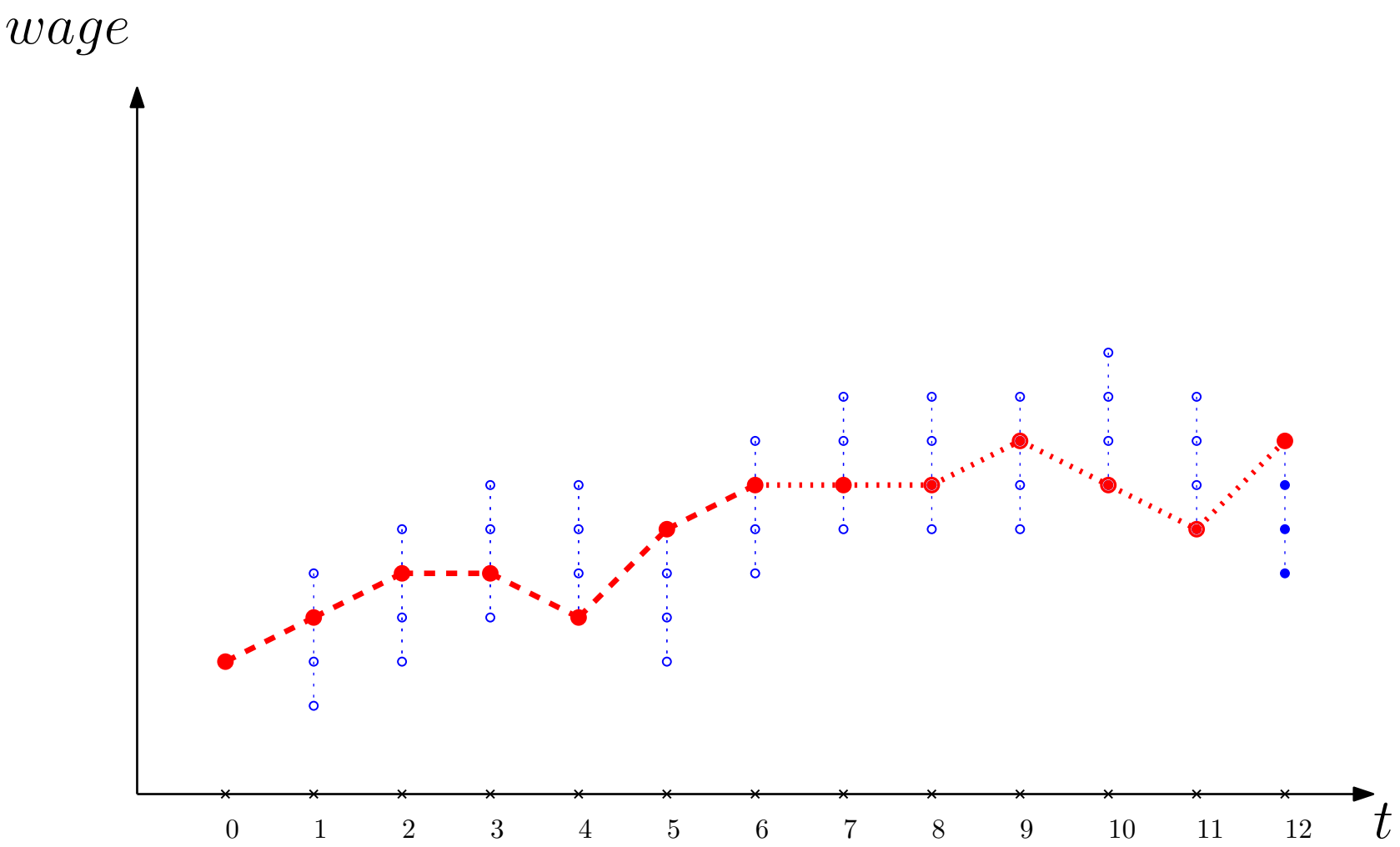


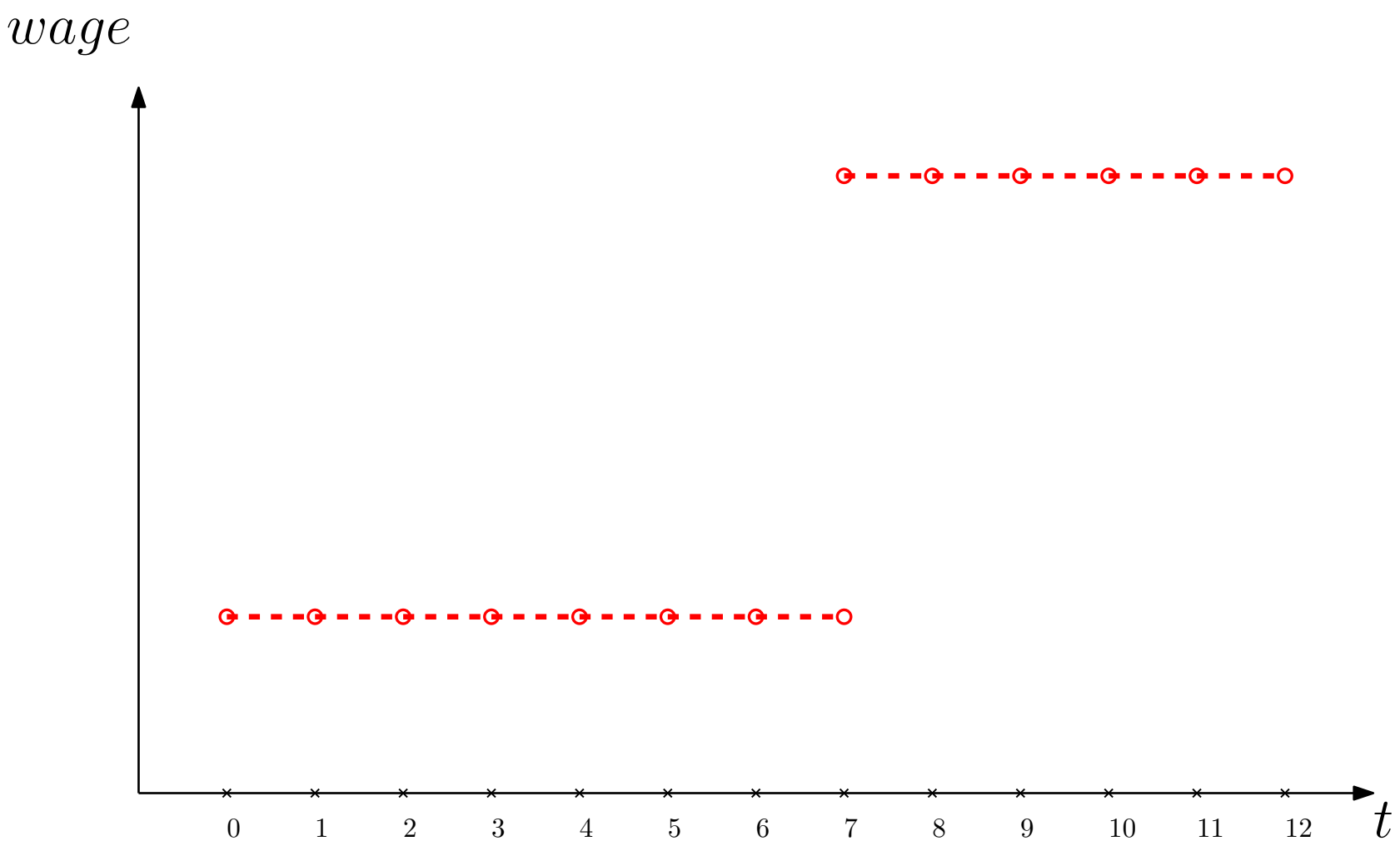
No Moral Hazard, Full Commitment



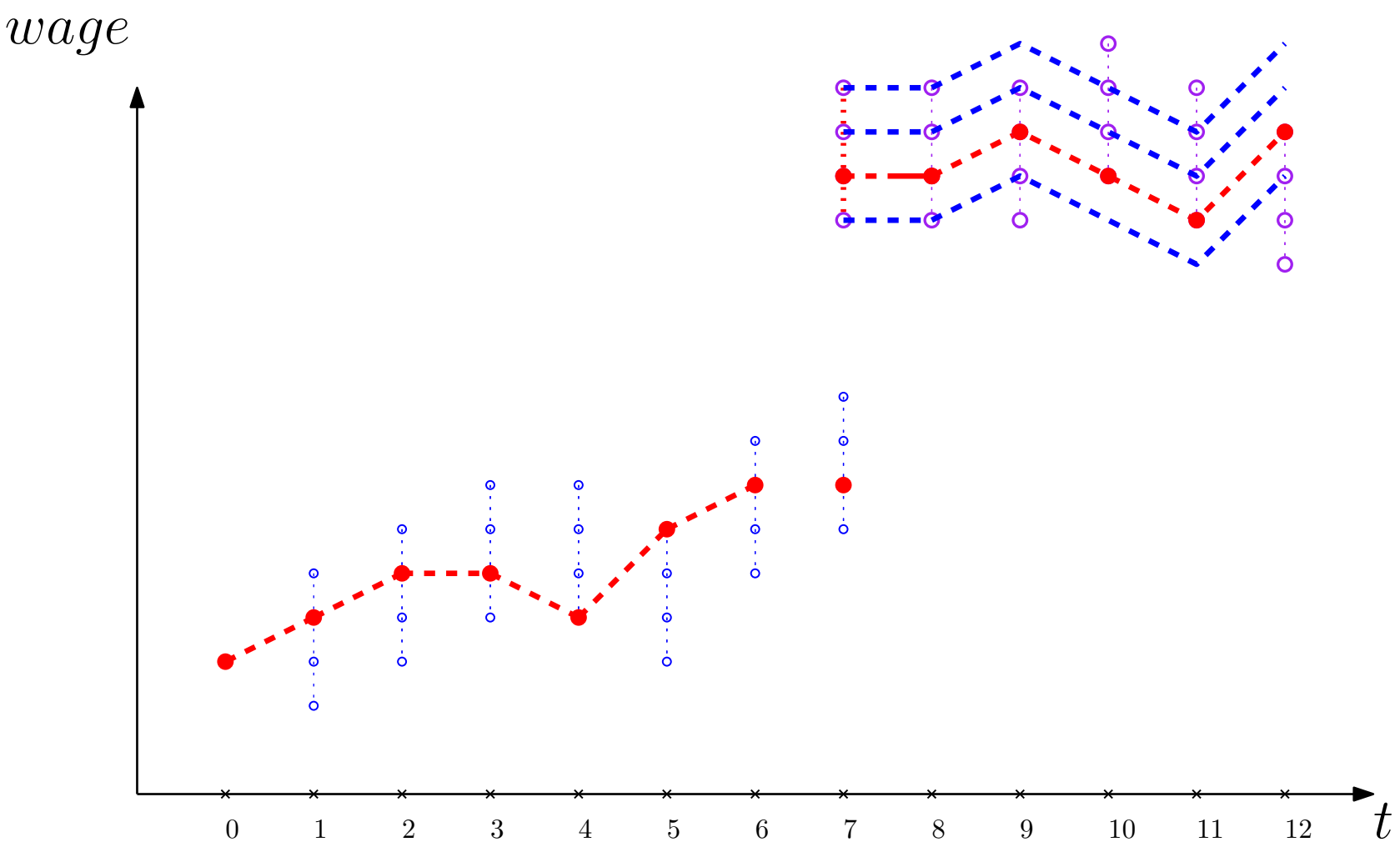
Only Moral Hazard



Only Limited Commitment



Optimal Contract



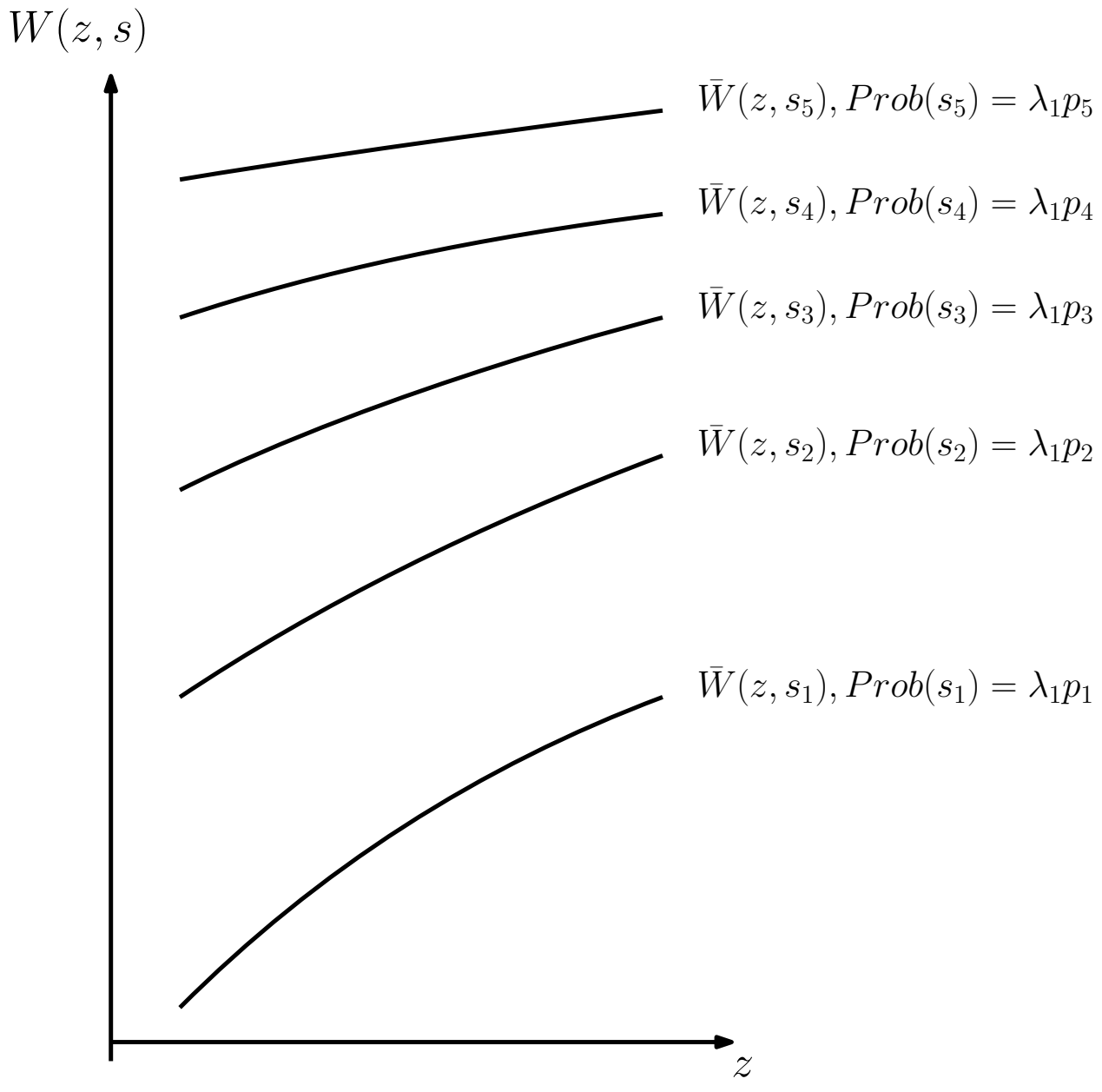
Market-based incentives

Proposition

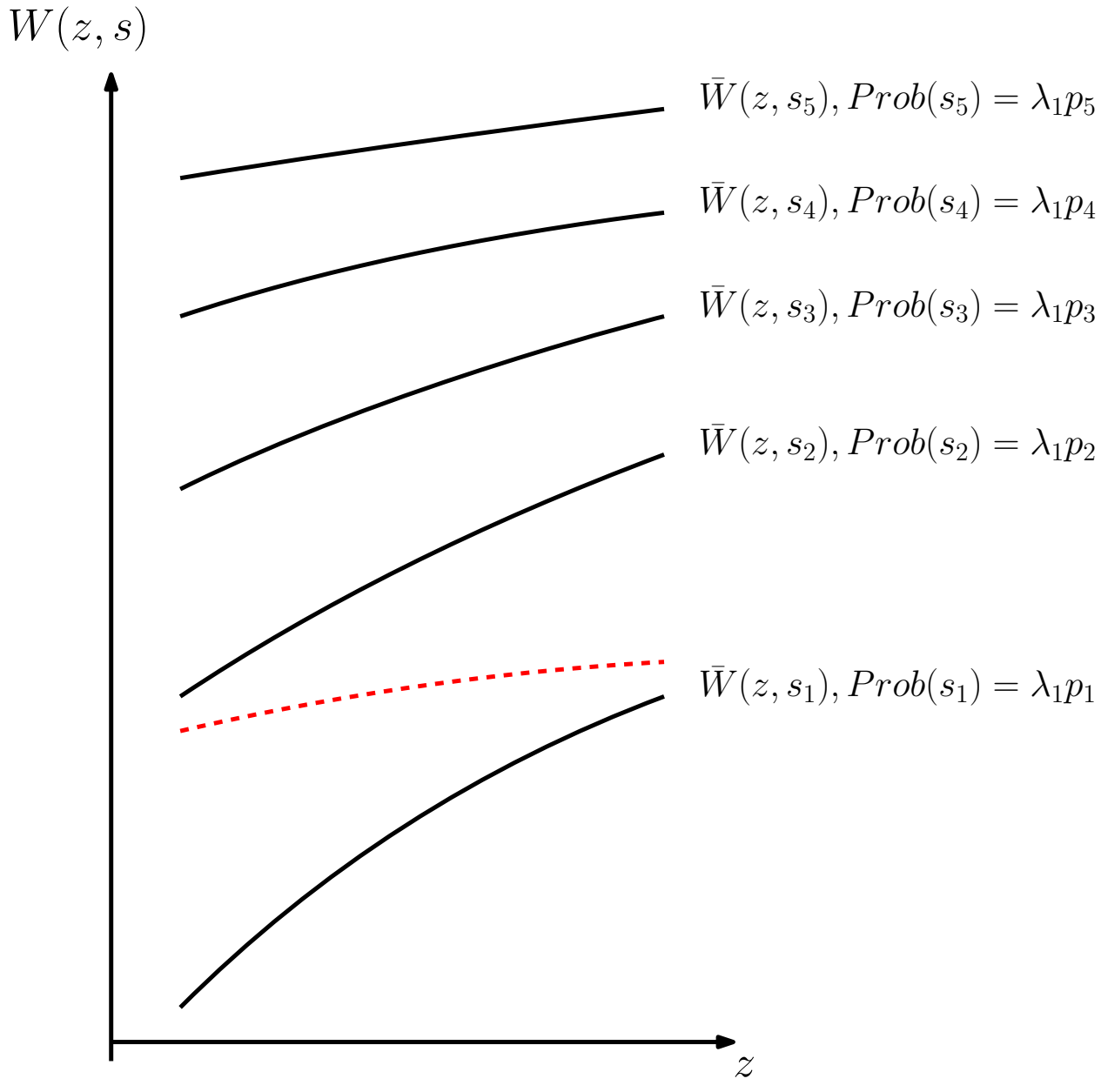
Market-based incentives decrease in firm size iff the utility function has a relative risk aversion larger than 1

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

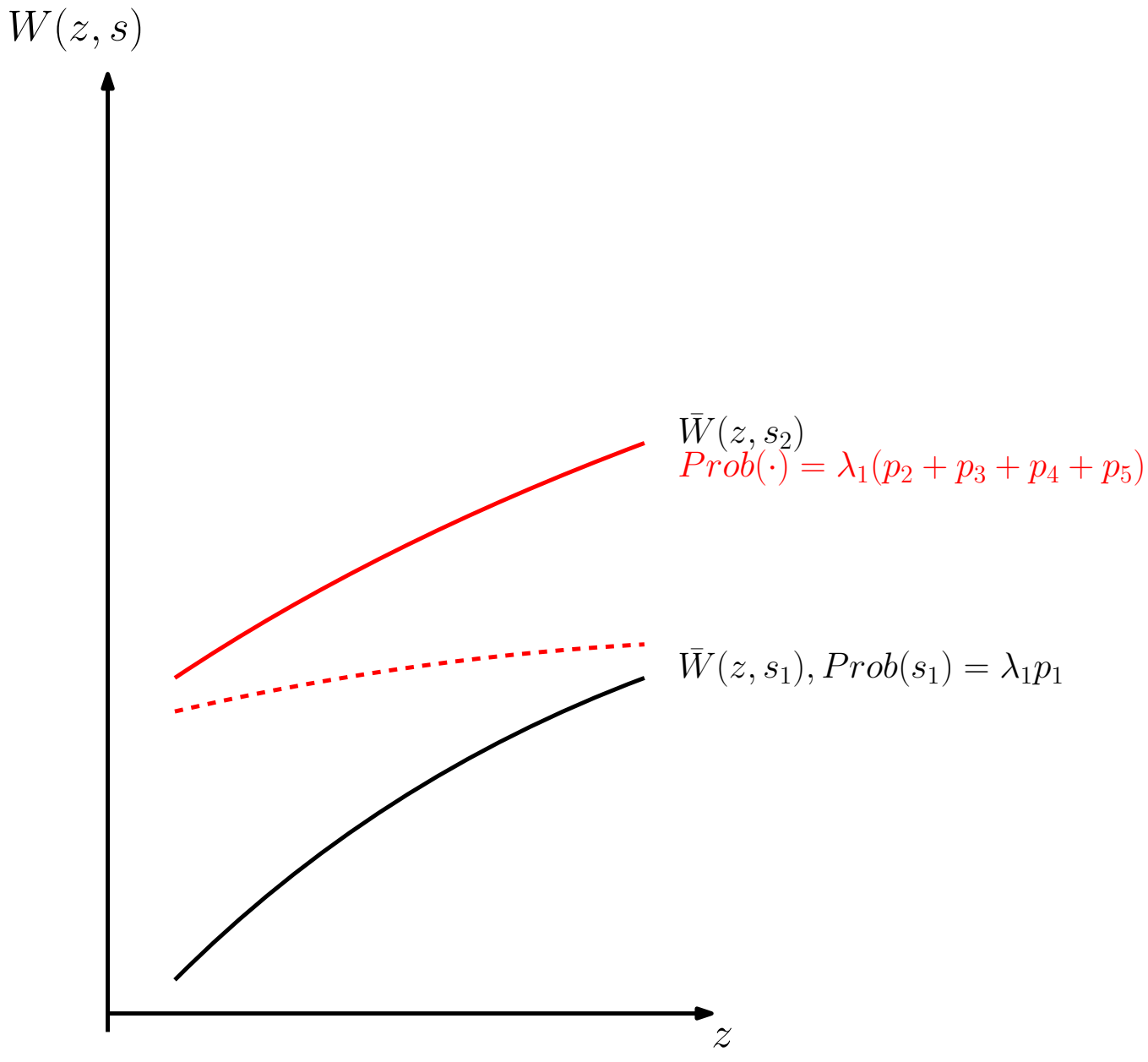
Bidding frontier is more flat as firm becomes larger



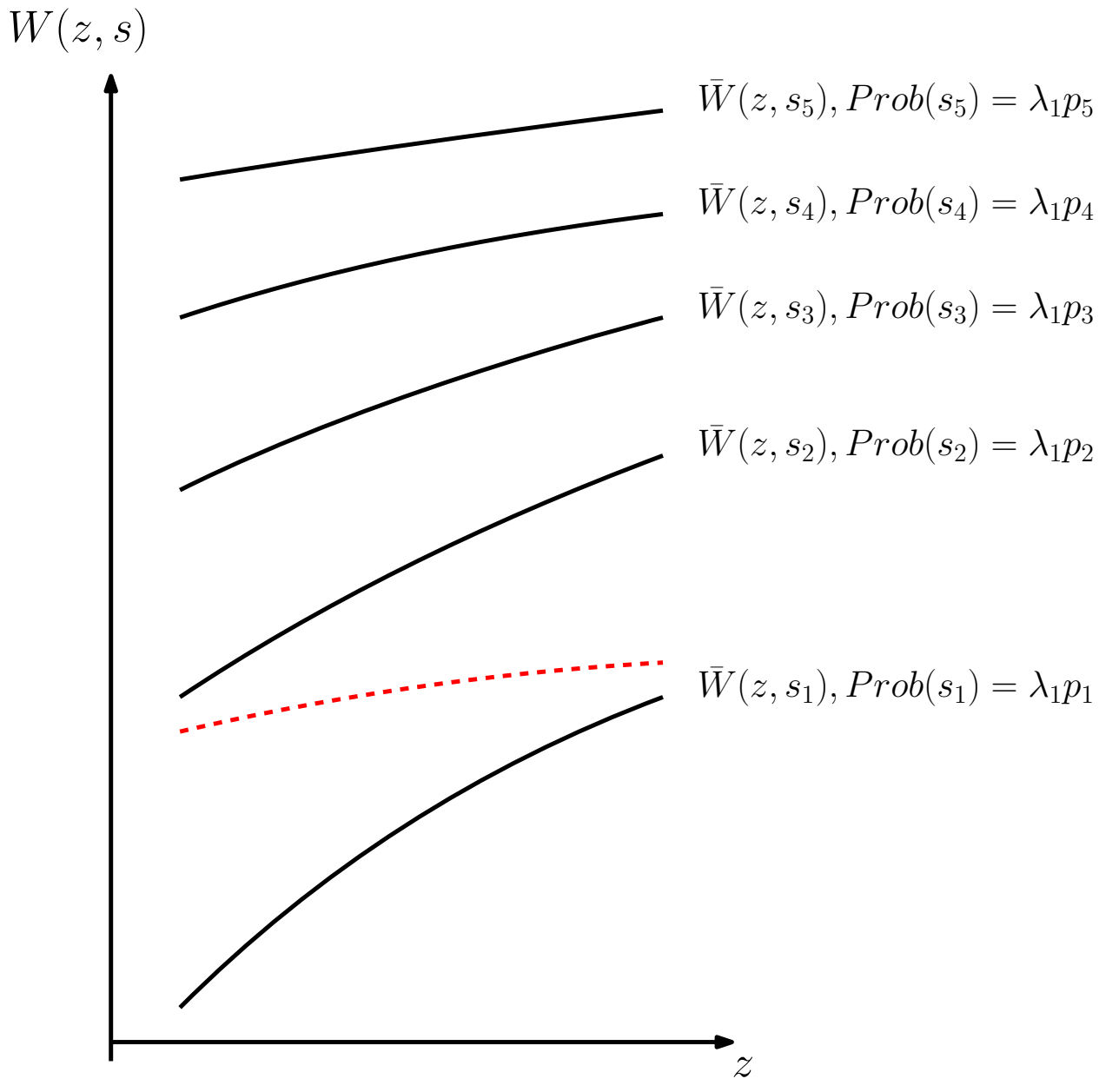
Market-based incentives for executive in firm s_2



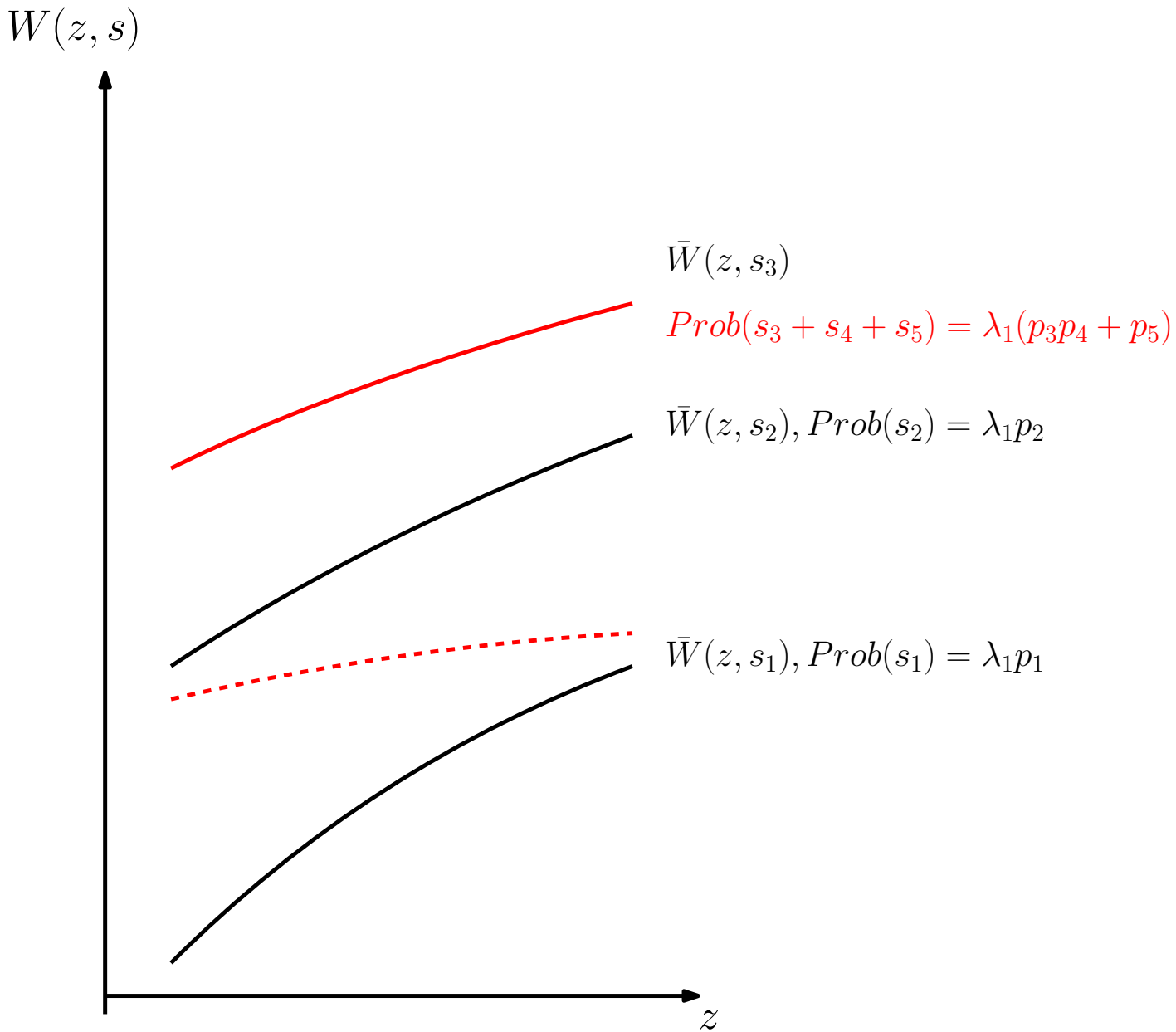
Market-based incentives for executive in firm s_2



Market-based incentives for executive in firm s_3



Market-based incentives for executive in firm s_3

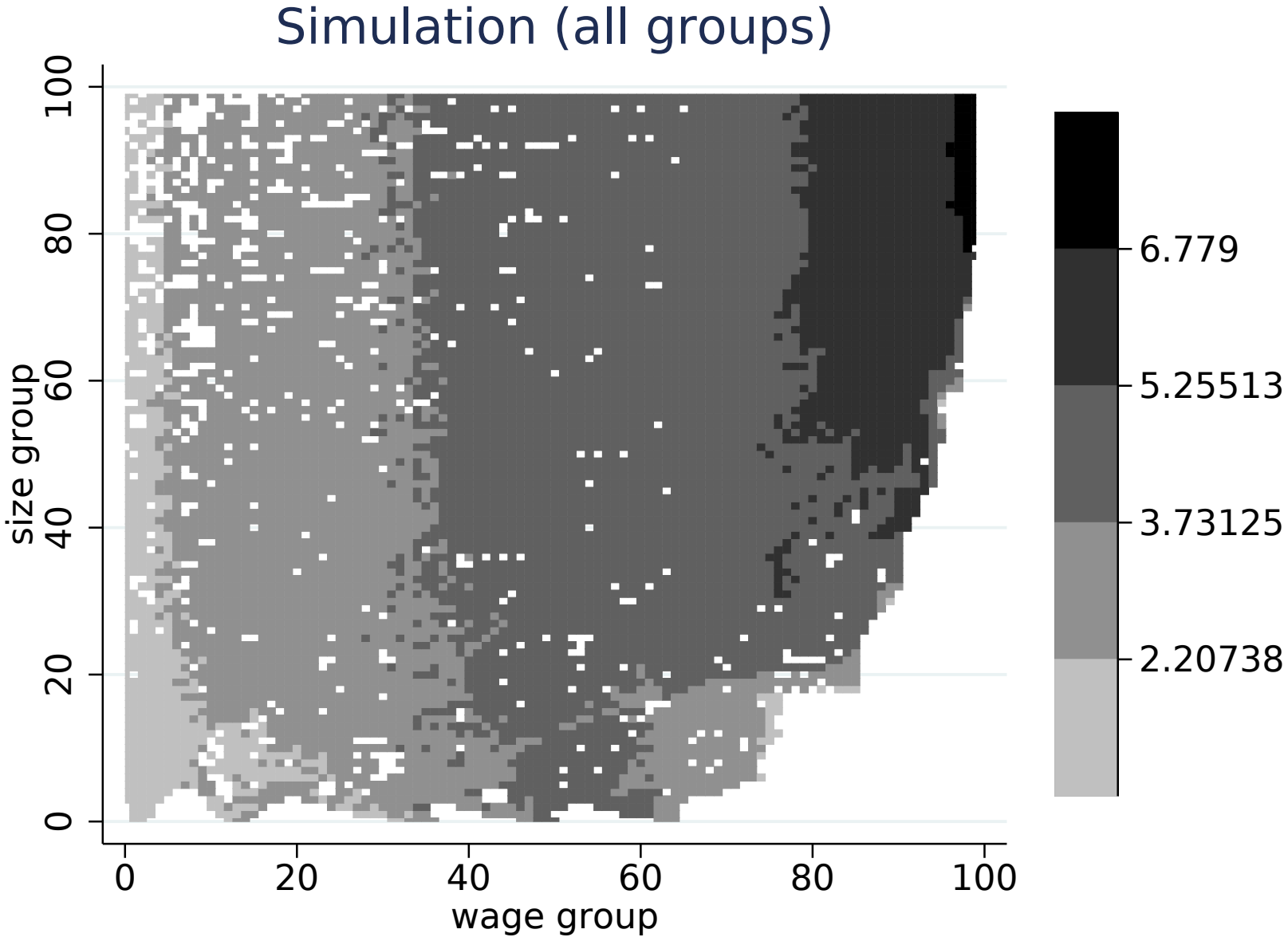


Estimation

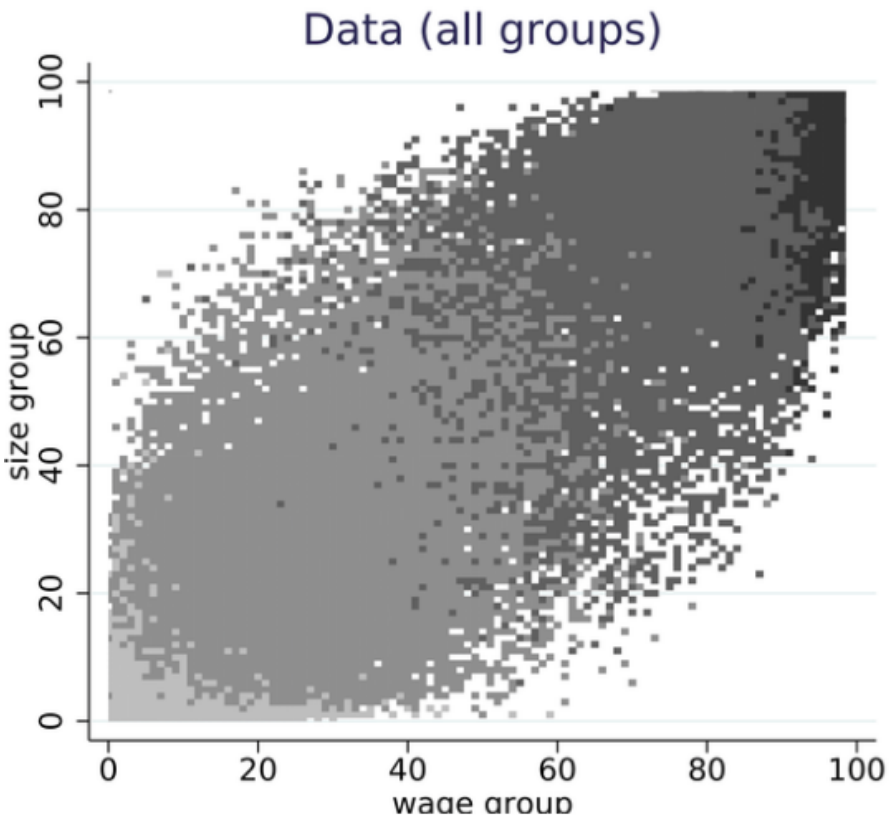
Moments and Estimation

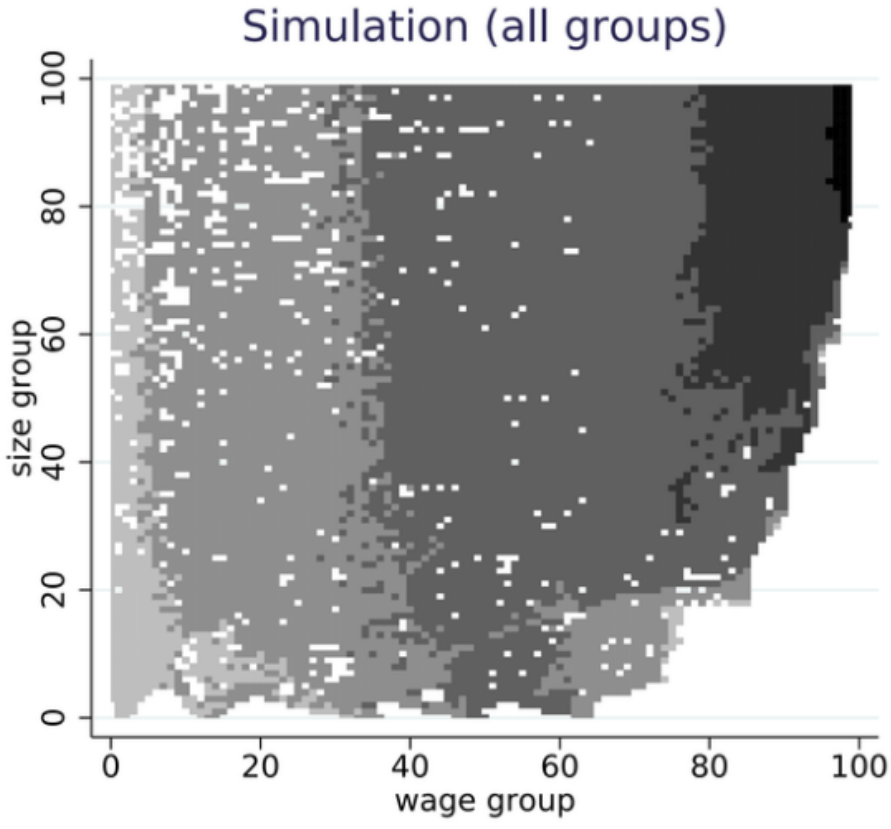
Moments	Target	Model	Estimates	Standard Error
Exit Rate	0.0691	0.0691	$\delta = 0.0691$	0.0012
EE Rate	0.0523	0.055	$\lambda_1 = 0.2759$	0.0017
$\hat{\rho}_z$	0.8111	0.5499	$\rho_z = 0.7$	0.0036
Mean(z)	0.1284	0.1763	$\mu_z^w = 0.06$	0.0006
Var(z)	0.0141	0.0141	$\sigma_z = 0.12$	0.0014
Mean(log(wage))	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



Model Predictions v.s. Data





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 incentives` and `market-based incentives`.
- `Market-based incentives` are smaller in larger firms. So larger firms need more performance-based pay.
- 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 incentives

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