# 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

- Amazon, compensation philosophy for named executives

  *"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 ..."*

- How do the executive labor market and pay incentives interact?

# Motivating Facts: size premium in performance incentives

- Sample: top 5 to 8 executives in S&P 1500 firms from 1992 to 2015
- Performance-based incentives:

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

- Stylized facts
  1. delta increases in firm size,

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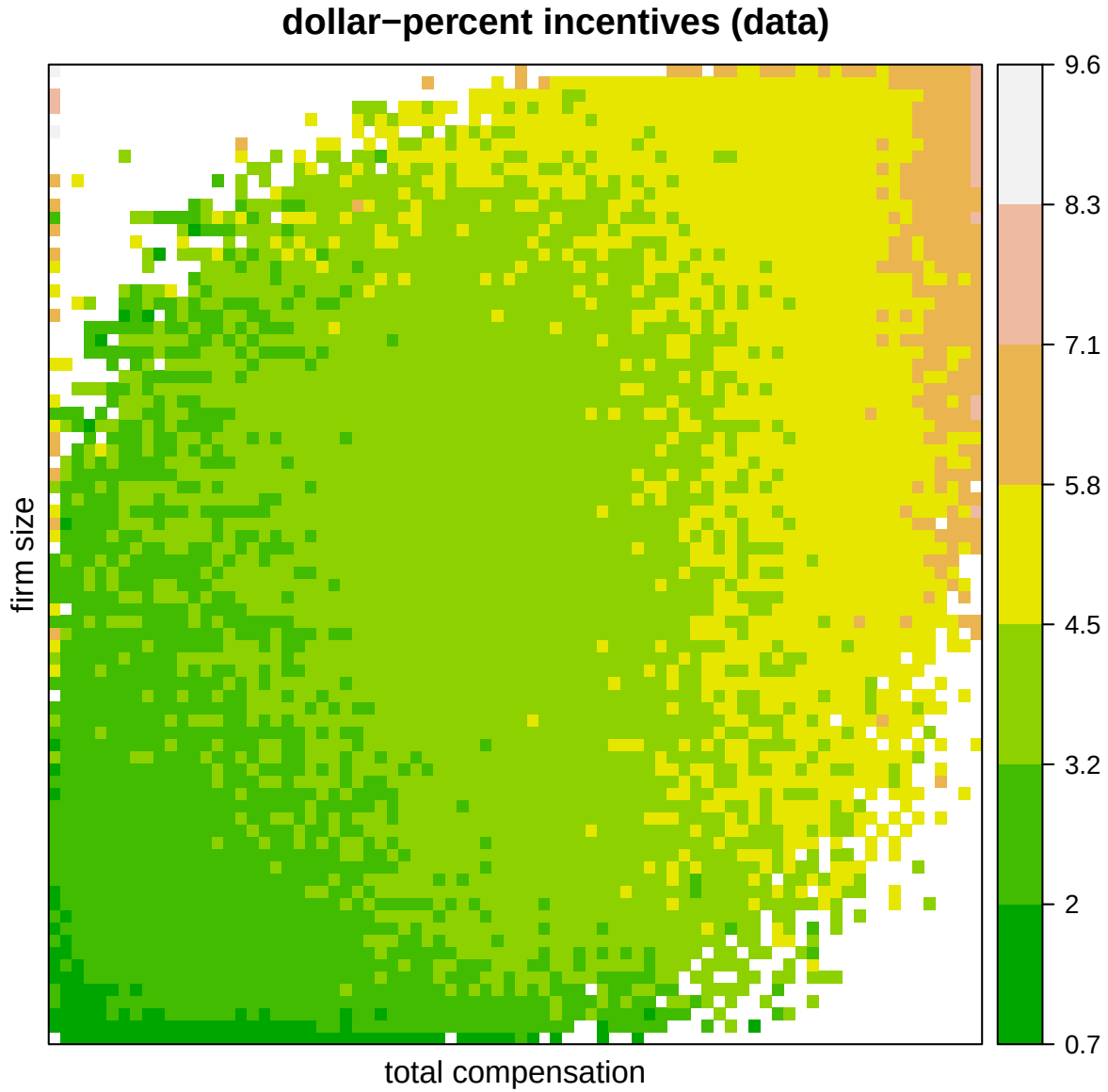
- Stylized facts
  1. delta increases in firm size, controlling for total compensation
  2. such firm size premium is larger in industries where the executive labor market is more active




Sample: top 5 to 8 executives in $S\&P1500$ firms from 1992 to 2015

Color (z): dollar-percent wealth-performance sensitivity

Table 1: Pay-for-performance Incentives Increase with Firm Size

| | log(*delta*) | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| log(Firm Size) | 0.571*** | 0.295*** | 0.257*** | 0.253*** |
| | (0.0153) | (0.0294) | (0.0252) | (0.0249) |
| log(tdc1) | | 0.682*** | | |
| | | (0.0555) | | |
| tdc1 Dummies (50) | | | Yes | |
| tdc1 Dummies (100) | | | | Yes |
| Age dummies | Yes | Yes | Yes | 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 |
| adj. R-sq | 0.392 | 0.491 | 0.502 | 0.505 |

*Note:* The standard error (clustered at the firm level) are shown in parentheses, and we denote symbols of significance by * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. The dependent variable is the log of delta. The independent variable is the log of firm size. The key control variable is total compensation.

Table 2: Firm Size Premium Increases with Market Competition

| | log(*delta*) | | |
|---|---|---|---|
| | (1) | (2) | (3) |
| log(Firm Size) | 0.348*** | 0.386*** | 0.257*** |
| | (0.00708) | (0.0189) | (0.0483) |
| log(tdc1) | 0.653*** | 0.596*** | 0.653*** |
| | (0.00445) | (0.0319) | (0.0269) |
| log(Firm Size) × External CEO | 0.0434* | | |
| | (0.0204) | | |
| GAI | | -0.428 | |
| | | (0.255) | |
| log(Firm Size) ×GAI | | 0.0702* | |
| | | ( 0.0325) | |
| Size Heterogeneity (sd/mean) | | | -2.652*** |
| | | | (0.784) |
| log(Firm Size) × Size Heter. | | | 0.218* |
| | | | (0.0993) |
| Age dummies | Yes | Yes | Yes |
| Year FEs | Yes | Yes | Yes |
| Industry FEs | Yes | Yes | Yes |
| Observations | 126533 | 77230 | 126533 |
| adj. R-sq | 0.505 | 0.512 | 0.506 |

*Note:* External CEO is measured by the percentage of new CEOs who are not insiders at the industry level (Gremers and Grinstein, 2014). GAI is the industry-year average of the general ability index composed by Cláudia, Ferreira and Matos (2013) .Size-Heterogeneity is the standard deviation of firm size within each industry-year group divided by the corresponding mean.

# Research Questions

Research Questions:

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

Main Story:

- The executive is motivated by *performance-based incentives* and *market-based incentives*.
- Market-based incentives decrease with firm size, so larger firms need to provide more performance-based incentives.

# 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. Structural Estimation using SMM

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

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# 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)

# The Model

# Set Up: Moral Hazard

Executives:

- risk averse, $u(w) - c(e)$, $e \in \{0, 1\}$, $c(1) = c$, $c(0) = 0$
- effort $e$ stochastically increases individual productivity $z \in \mathcal{Z}$
- $z$ is persistent
  - $z'$ 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

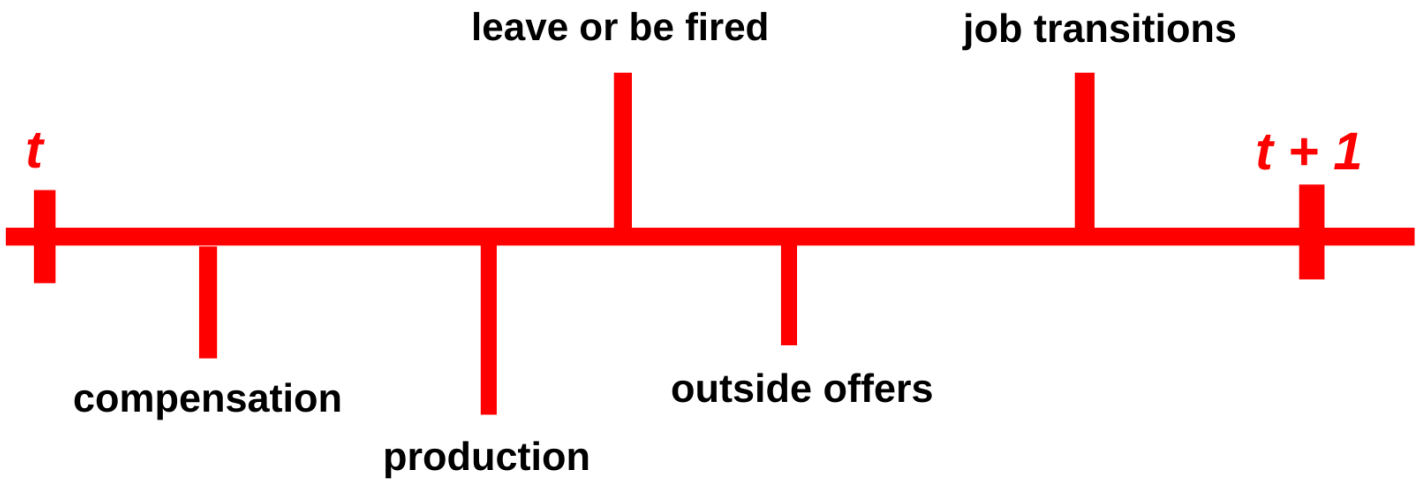
Search Market:

- on the job search
- with $\lambda \in (0,1)$ sample an outside firm $s'$ 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 $s$
- $s' > s$ leads to job turnovers

# Timing


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

# 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

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

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

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

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

# Contracting Problem

Insert in the optimal contract, the incentive compatibility constraint becomes

$$\tilde{\beta}\sum_{z'}\Bigg[\underbrace{\lambda_1\sum_{s'\in\mathcal{M}_1}F(s')\overline{W}(z',s)+\lambda_1\sum_{s'\in\mathcal{M}_2}\overline{W}(z',s')F(s')}_{\text{Market-based Incentives}}$$

$$+\underbrace{\Big(1-\lambda_1\sum_{s'\in\mathcal{M}_1\cup\mathcal{M}_2}F(s')\Big)W(z')}_{\text{Performance-based Incentives}}\Bigg](1-g(z,z'))\Gamma(z,z')\geq c. \quad (IC')$$

Sets of outside firms $s'$:

$\mathcal{M}_1 : s' \geq s,$ leads to job turnovers

$\mathcal{M}_2 : s' < s,$ improve compensation, no job turnovers

# The Equilibrium

## Equilibrium

An equilibrium is the executive unemployment value $W^0$, the value function of employed executives $W$, the profit function of the firms $\Pi$ and an optimal contract policy $\sigma = \{w, e, W(z')\}$ for $z' \in \mathbb{Z}$ that solves the contracting problem with associated constraints, the stochastic process of executive productivity $\Gamma$ follows the optimal effort choice and a distribution of executives across employment states evolving according to flow equations.

## Existence of the equilibrium

The equilibrium exists.
Proof: applying Schauder's fixed point theorem

# 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

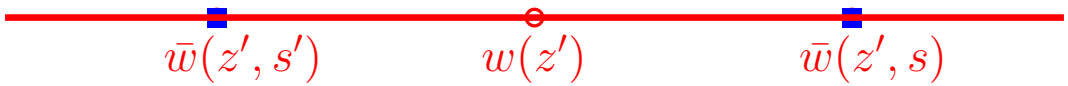
$$\frac{\partial \Pi(z', s, W(z'))}{\partial W(z')} = \frac{\partial \Pi(z, s, V)}{\partial V} - \mu(1 - g(z, z')).$$

# The Optimal Contract in terms of wage $w$

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

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

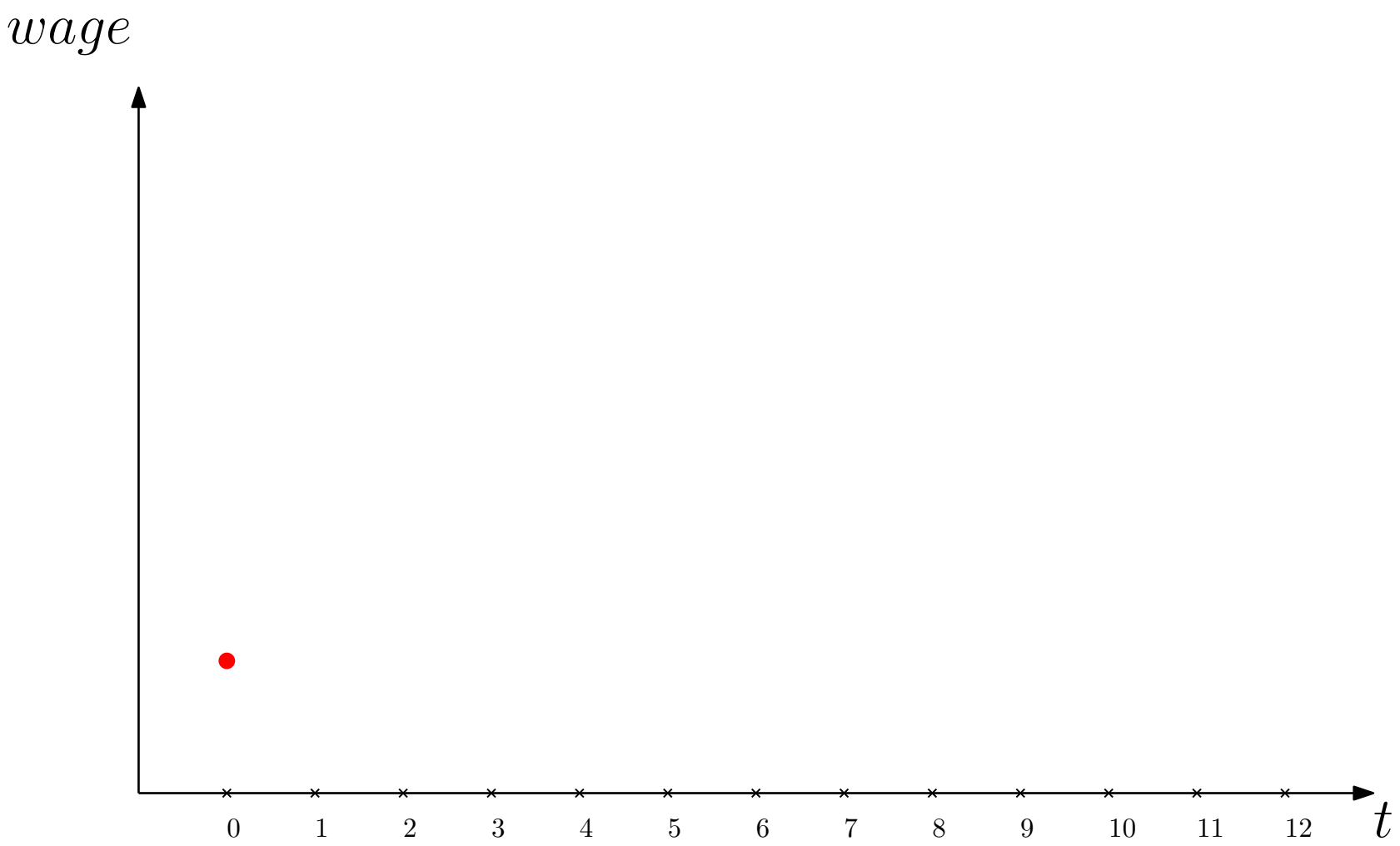
where $w(z') = w(z) + \mu(1 - g(z, z')$.




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


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

# Optimal Contract



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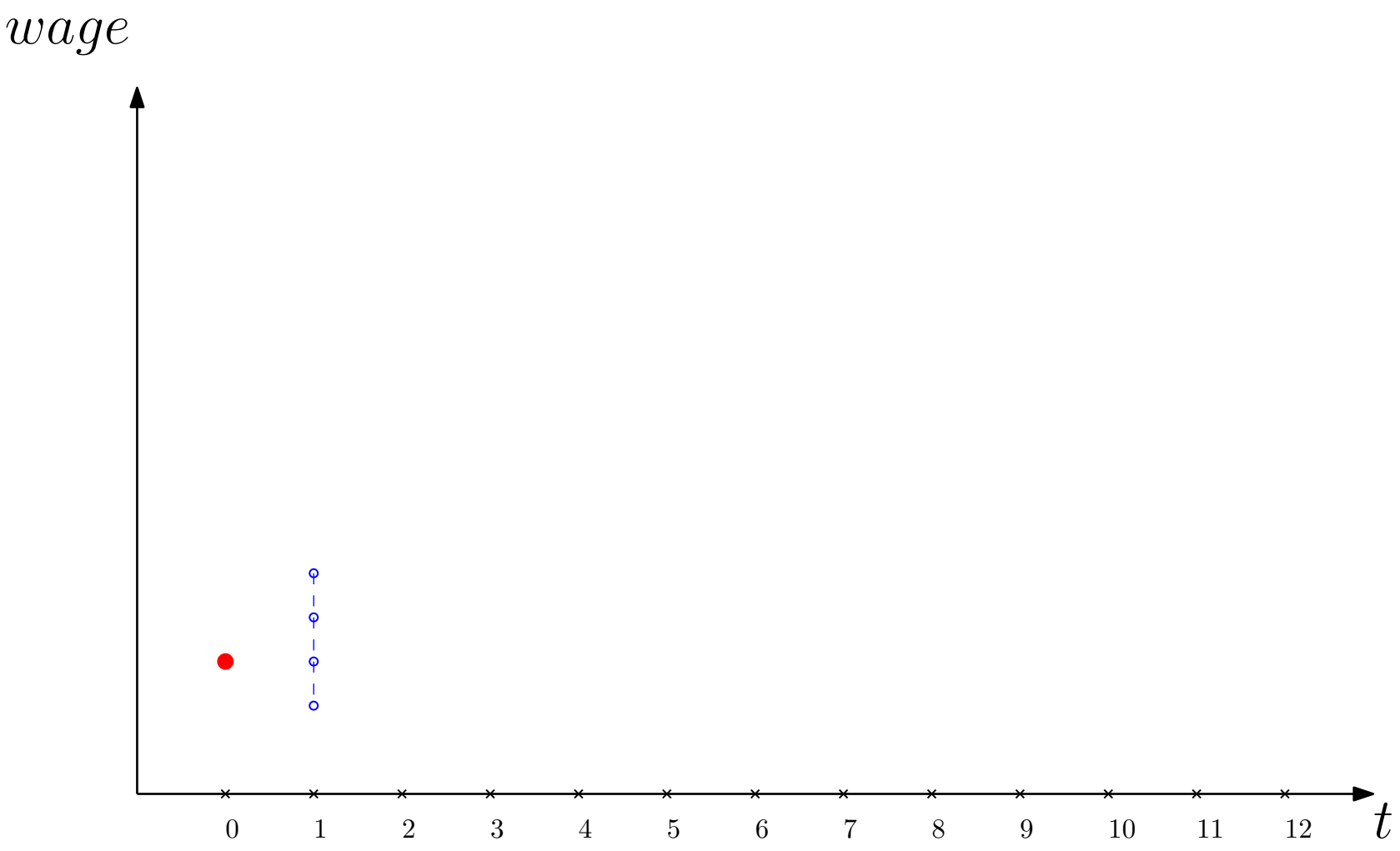

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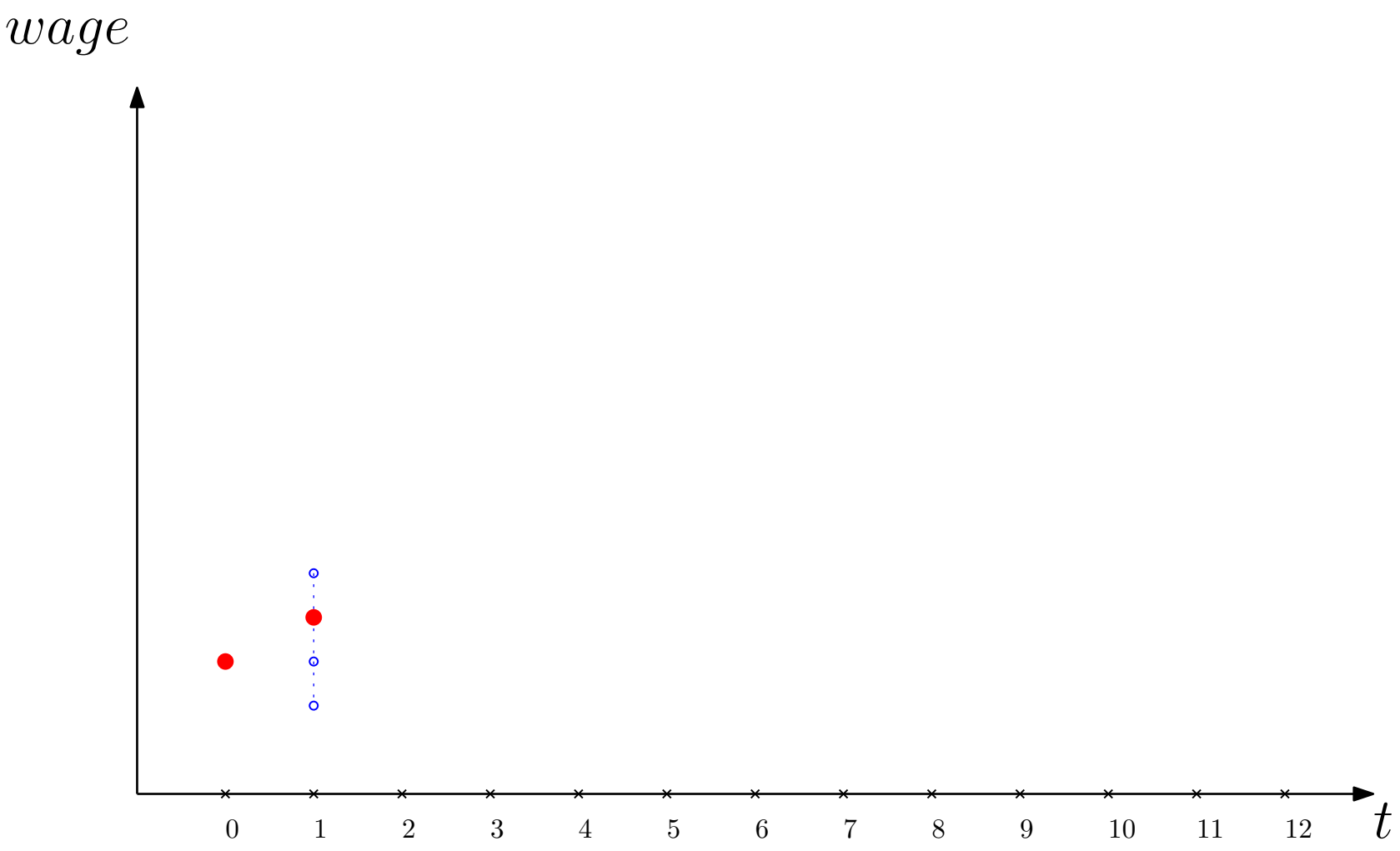

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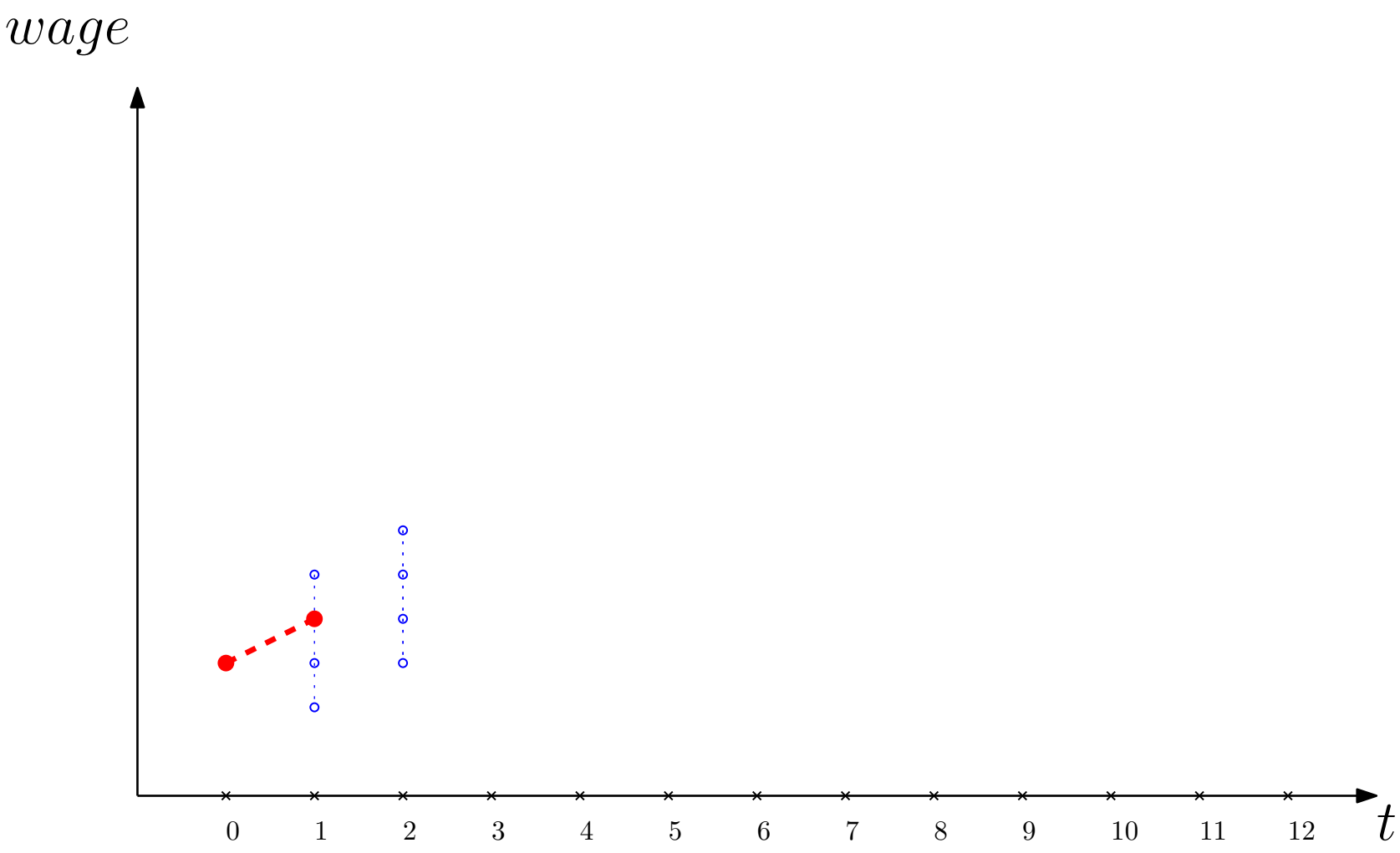

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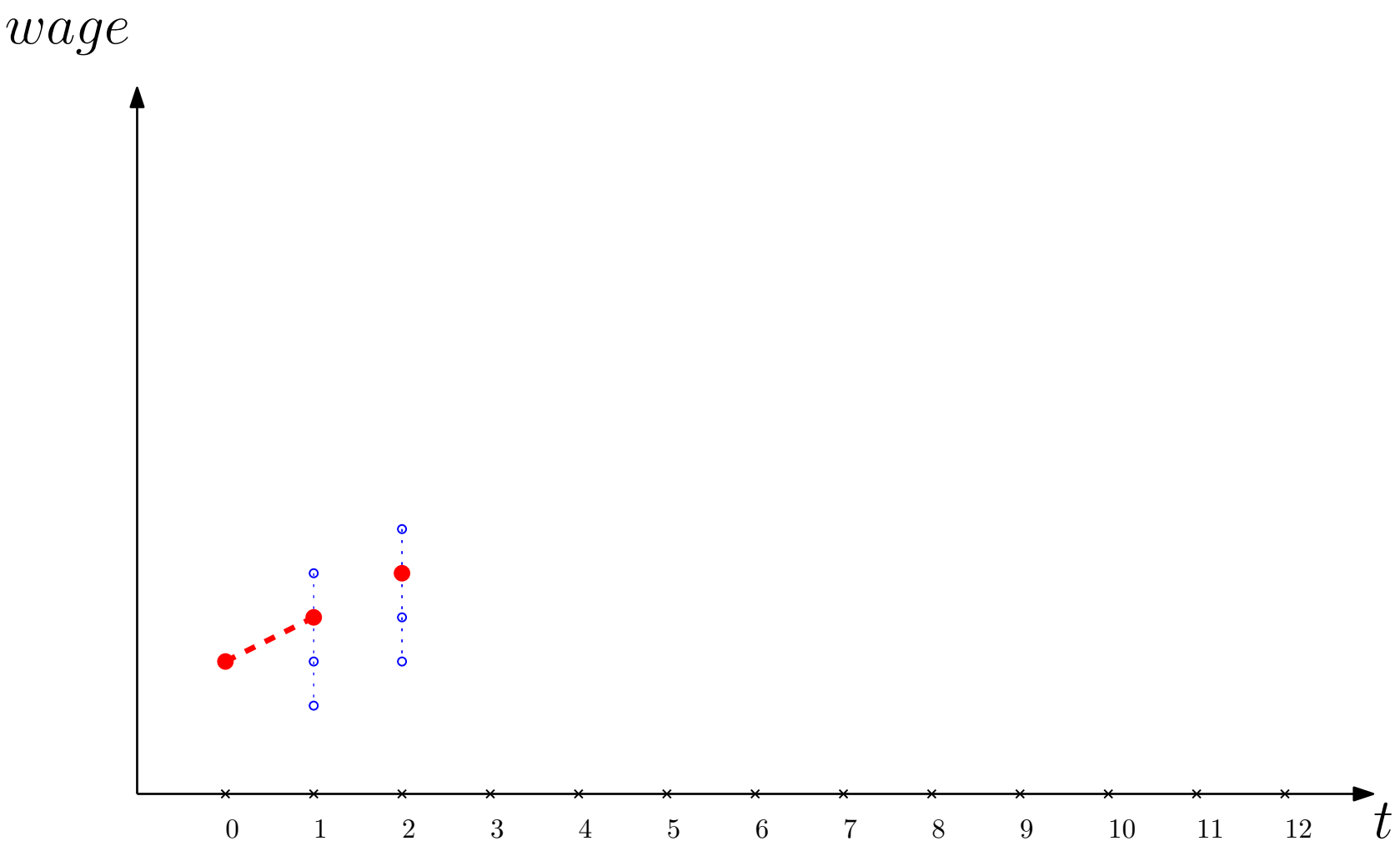

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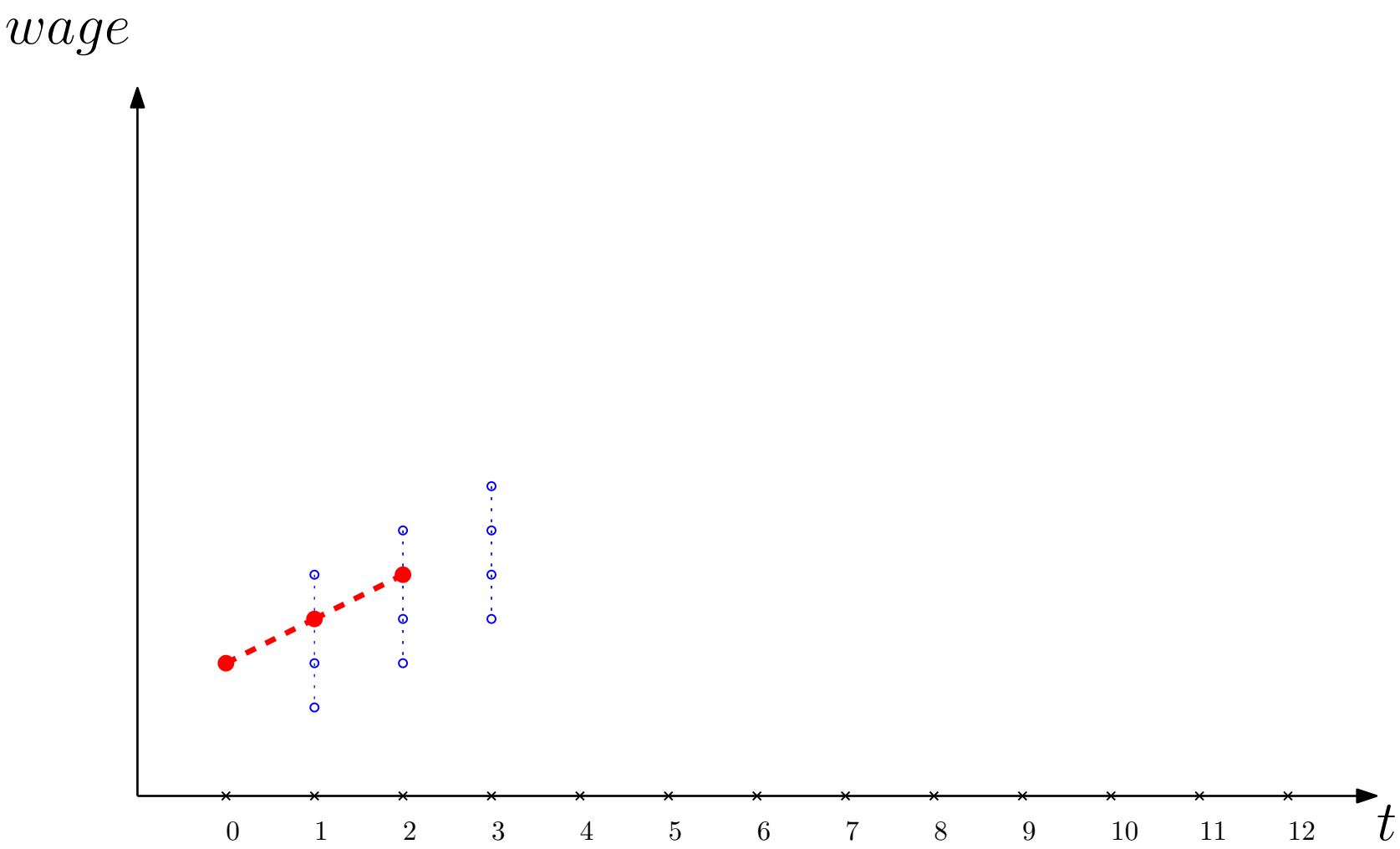

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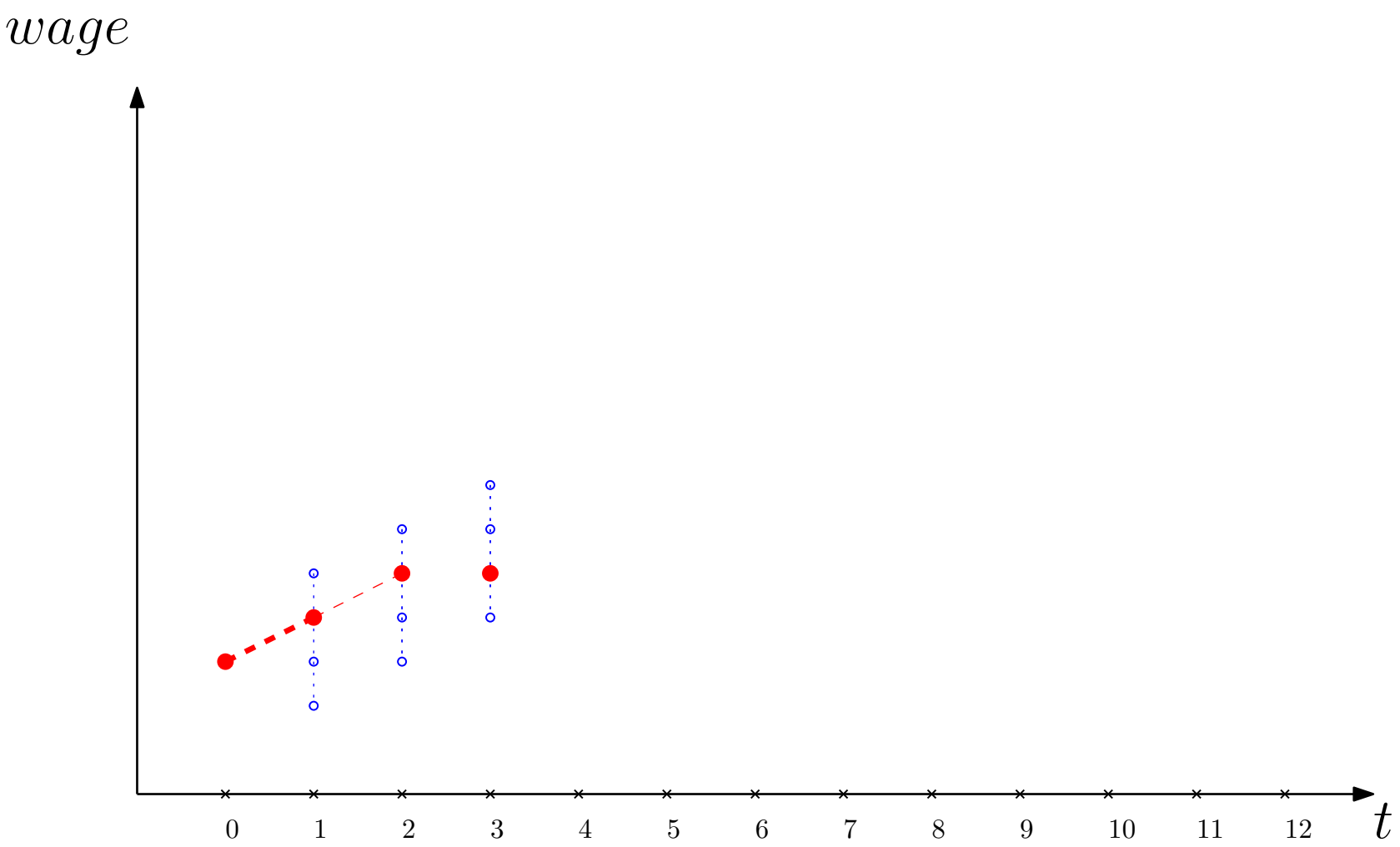

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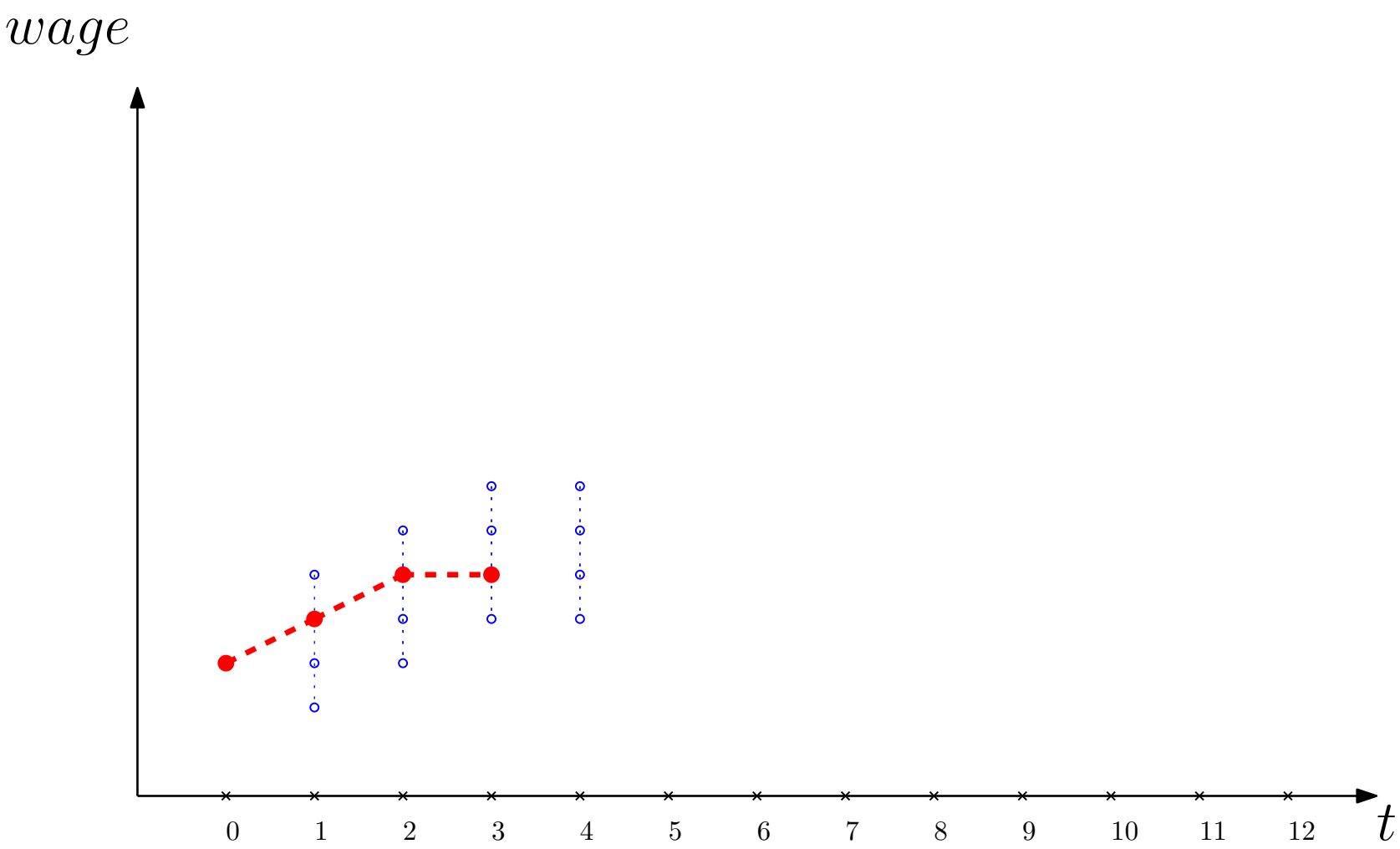

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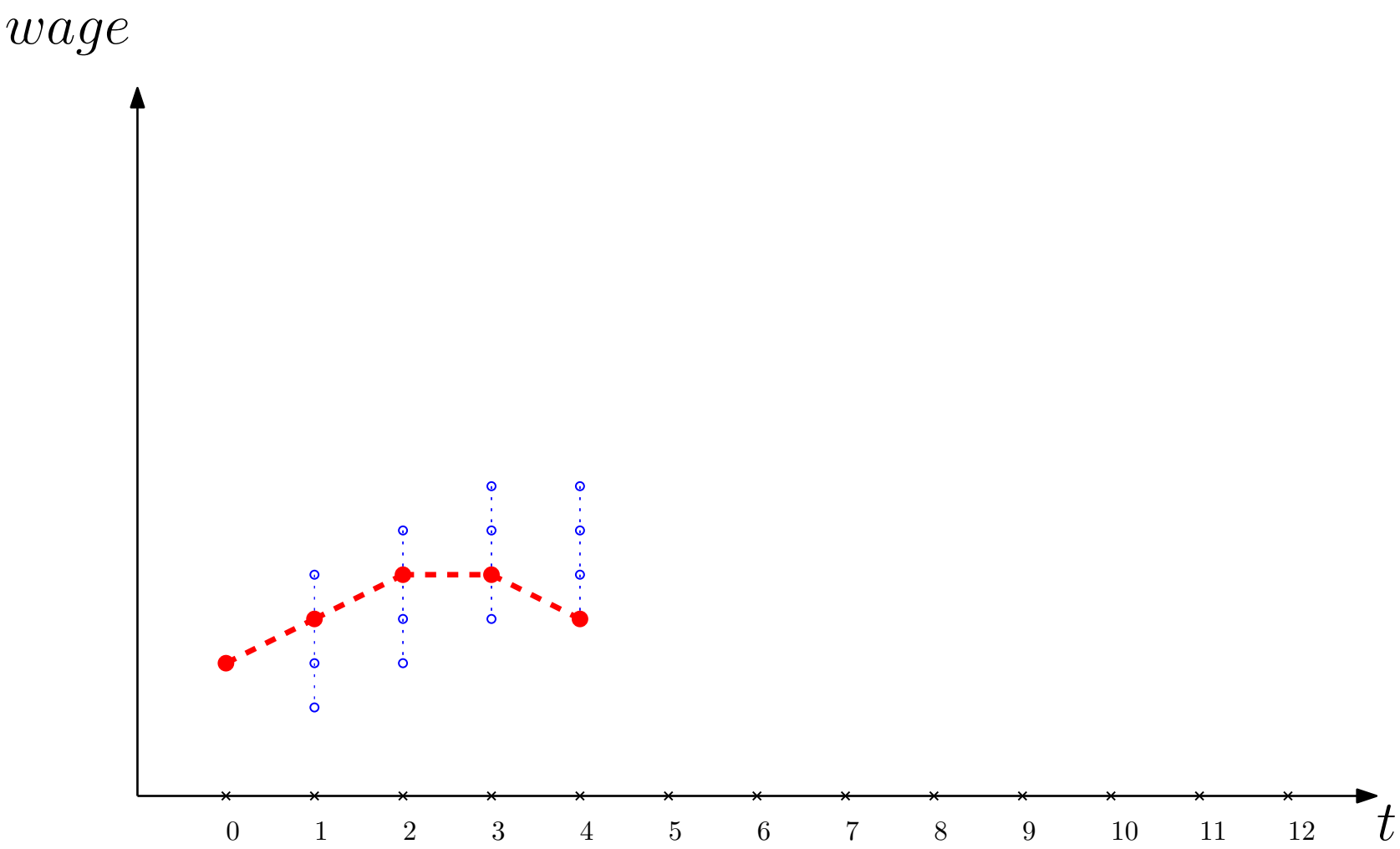

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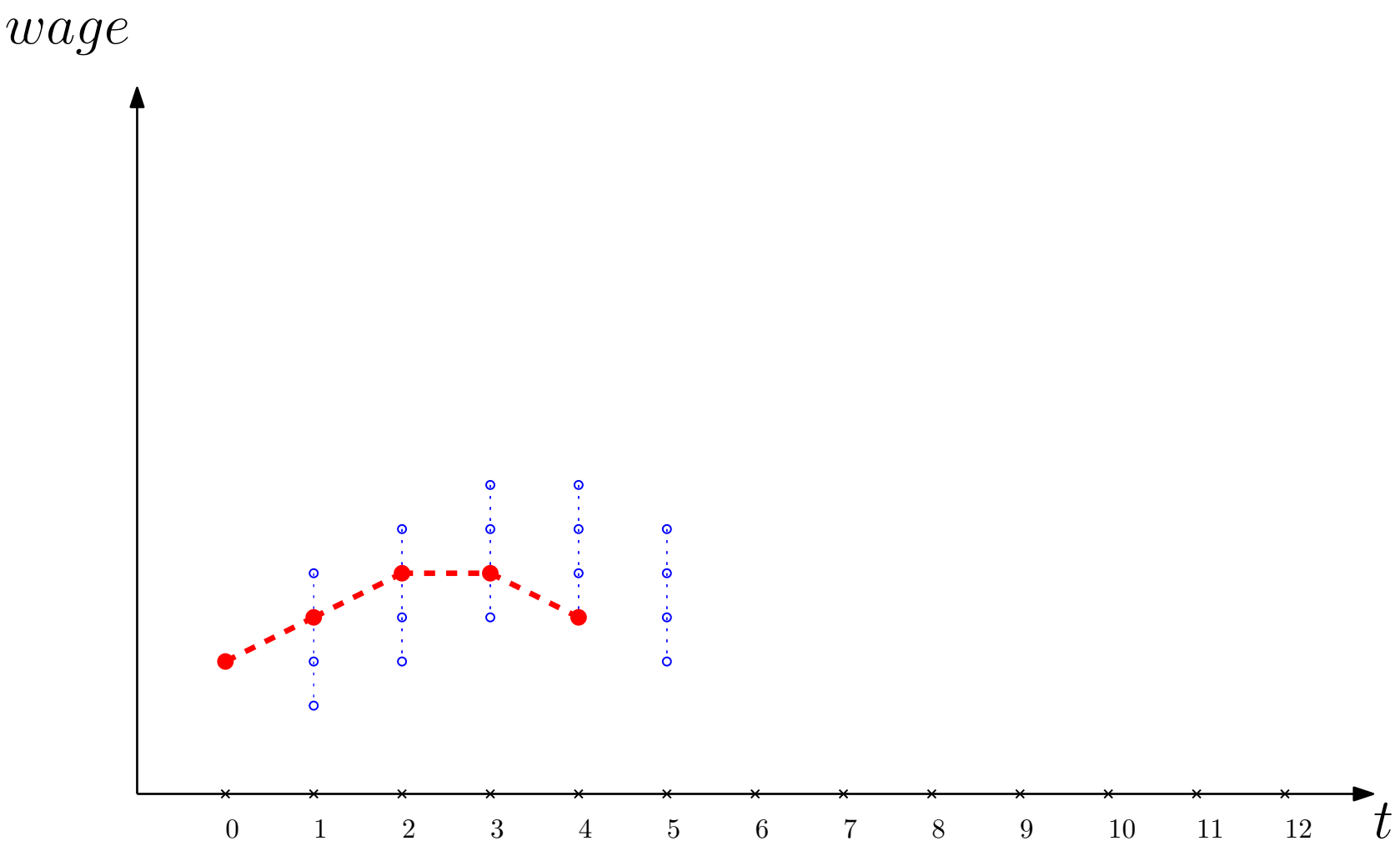

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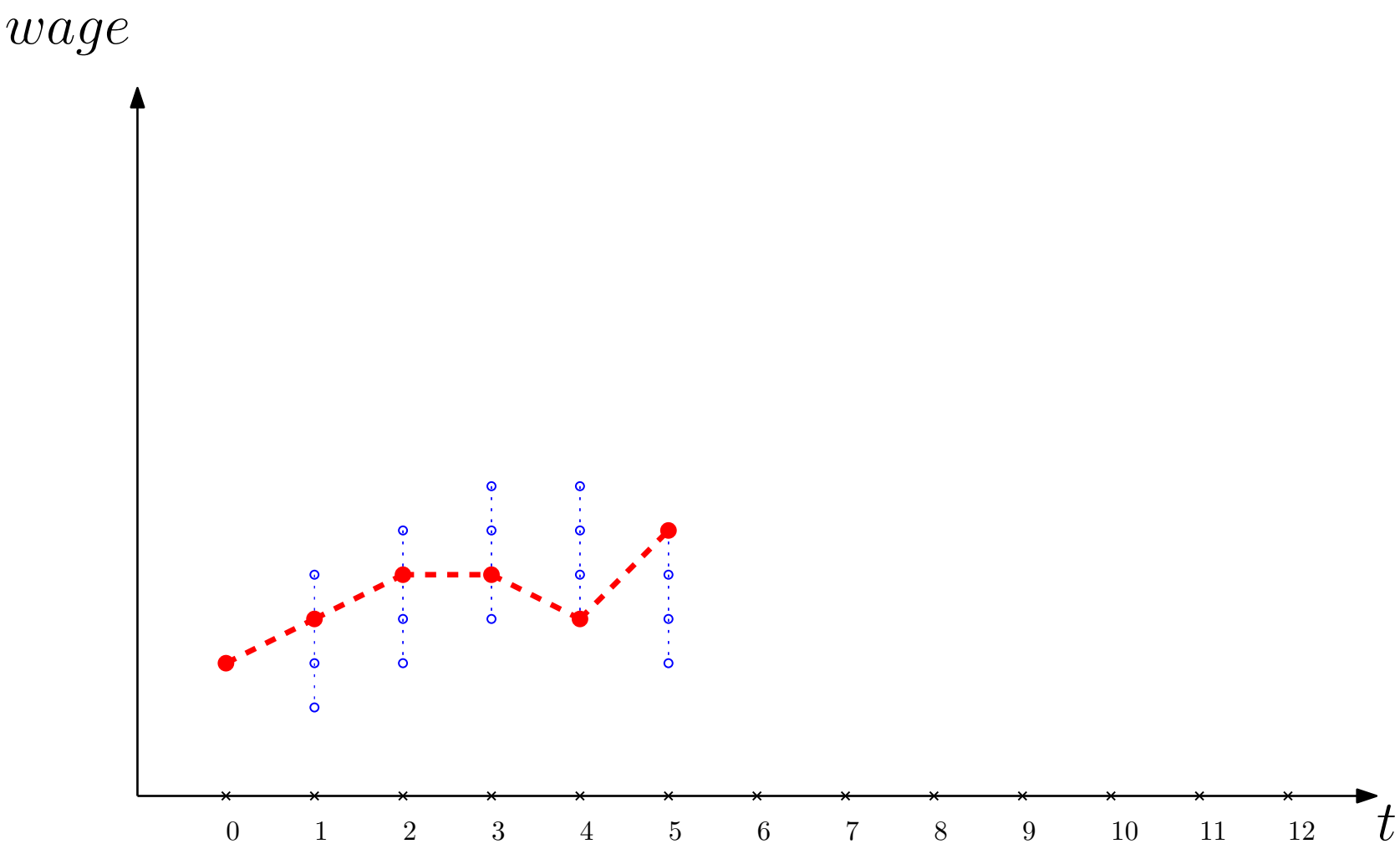

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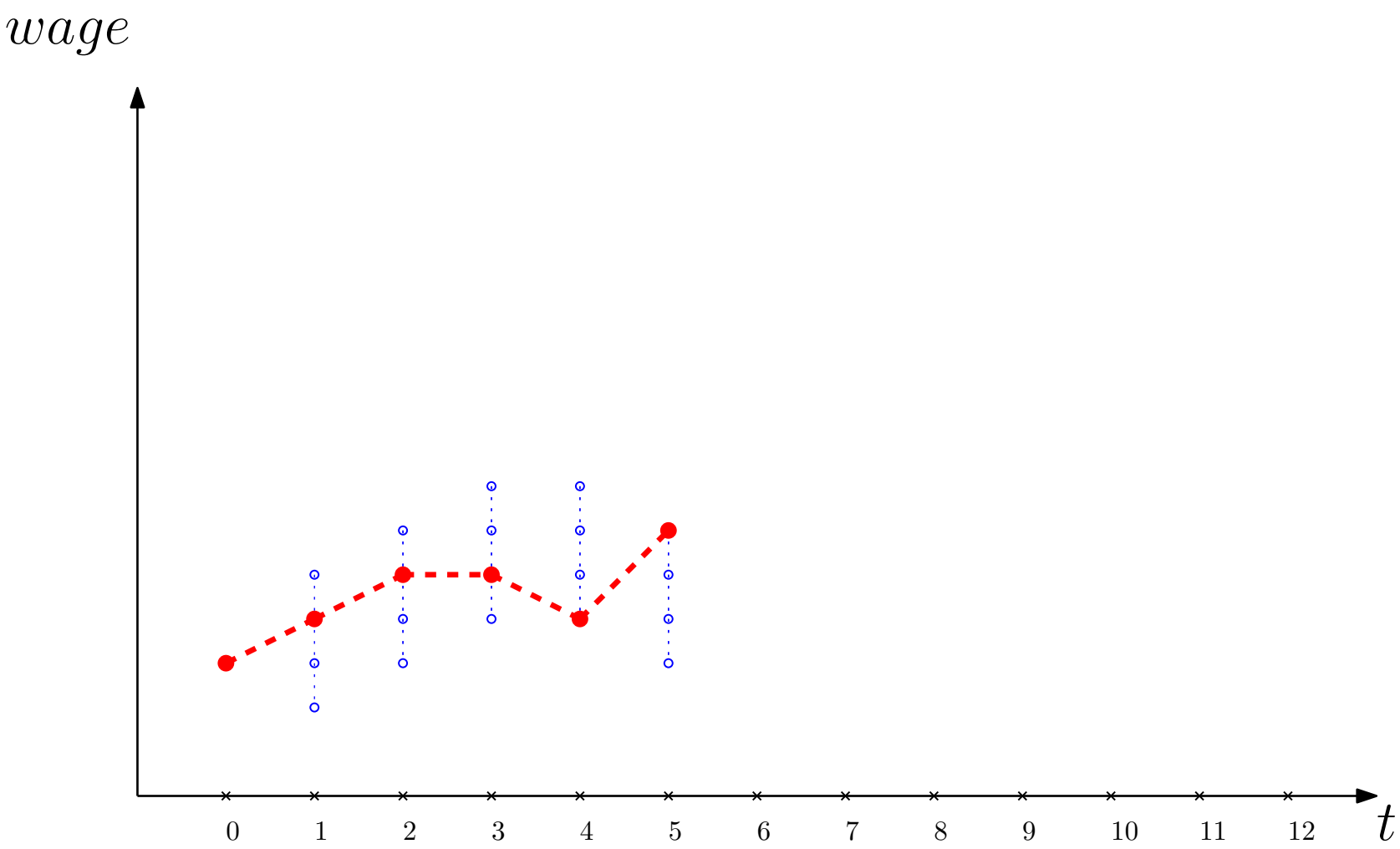

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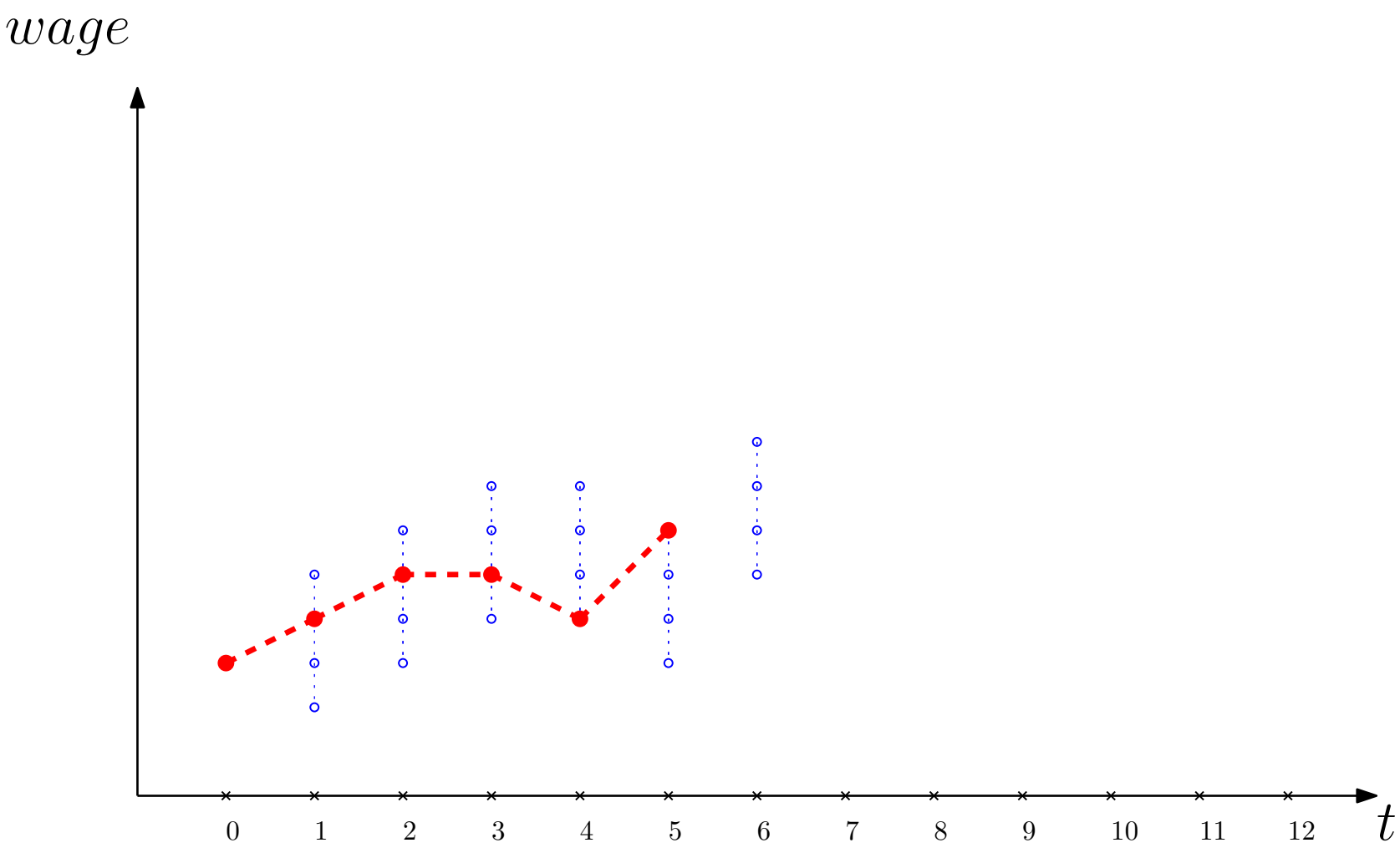

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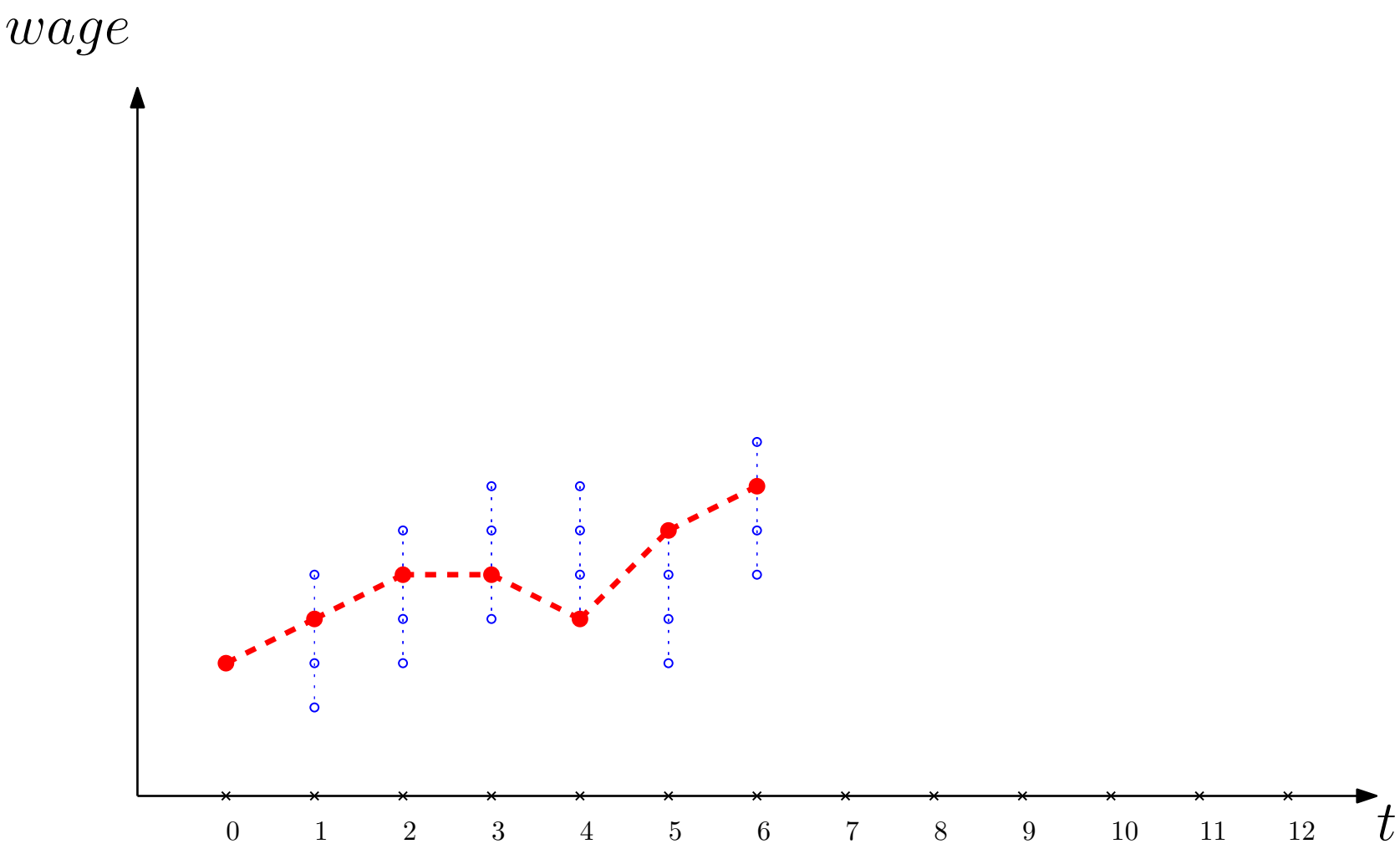

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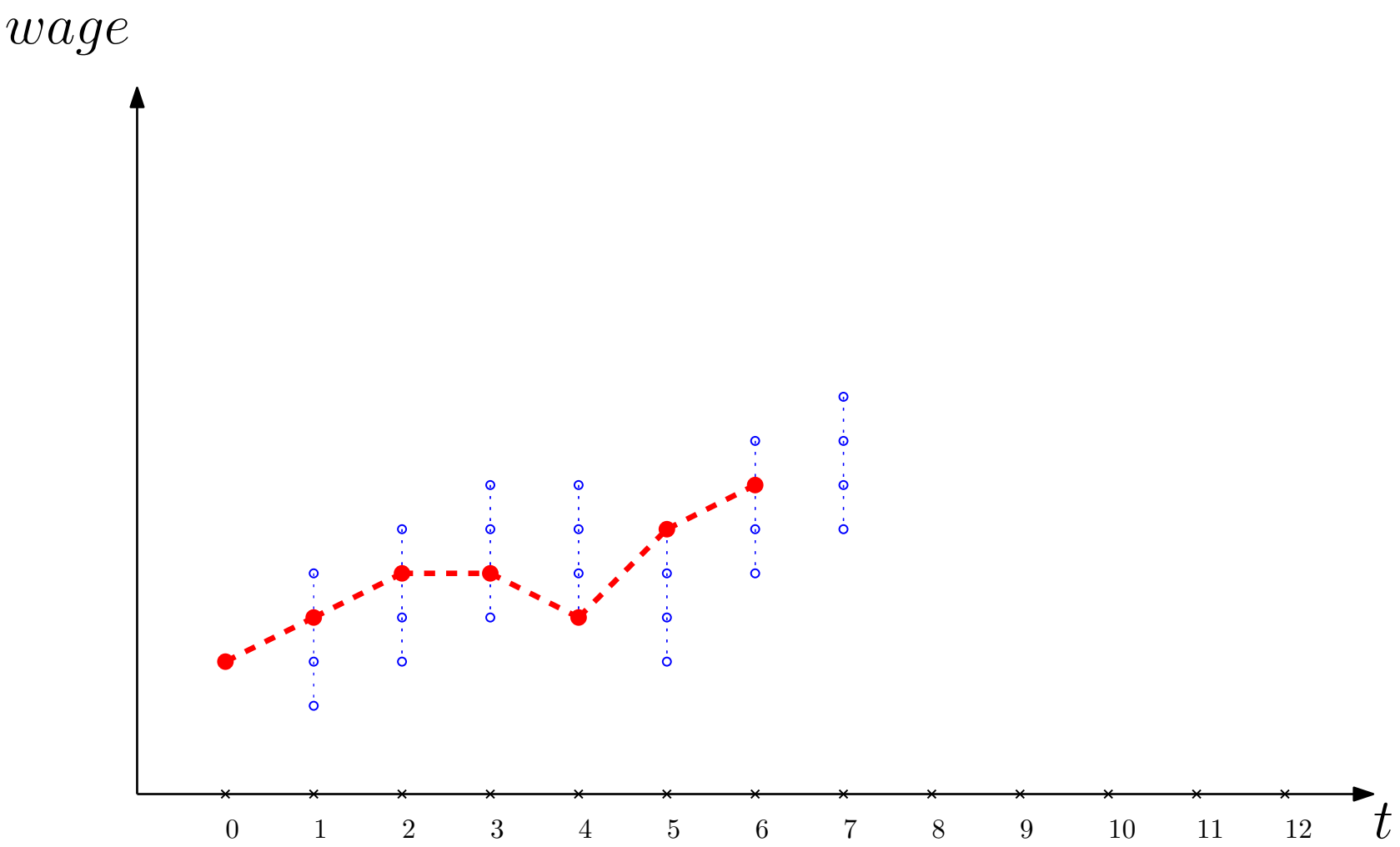

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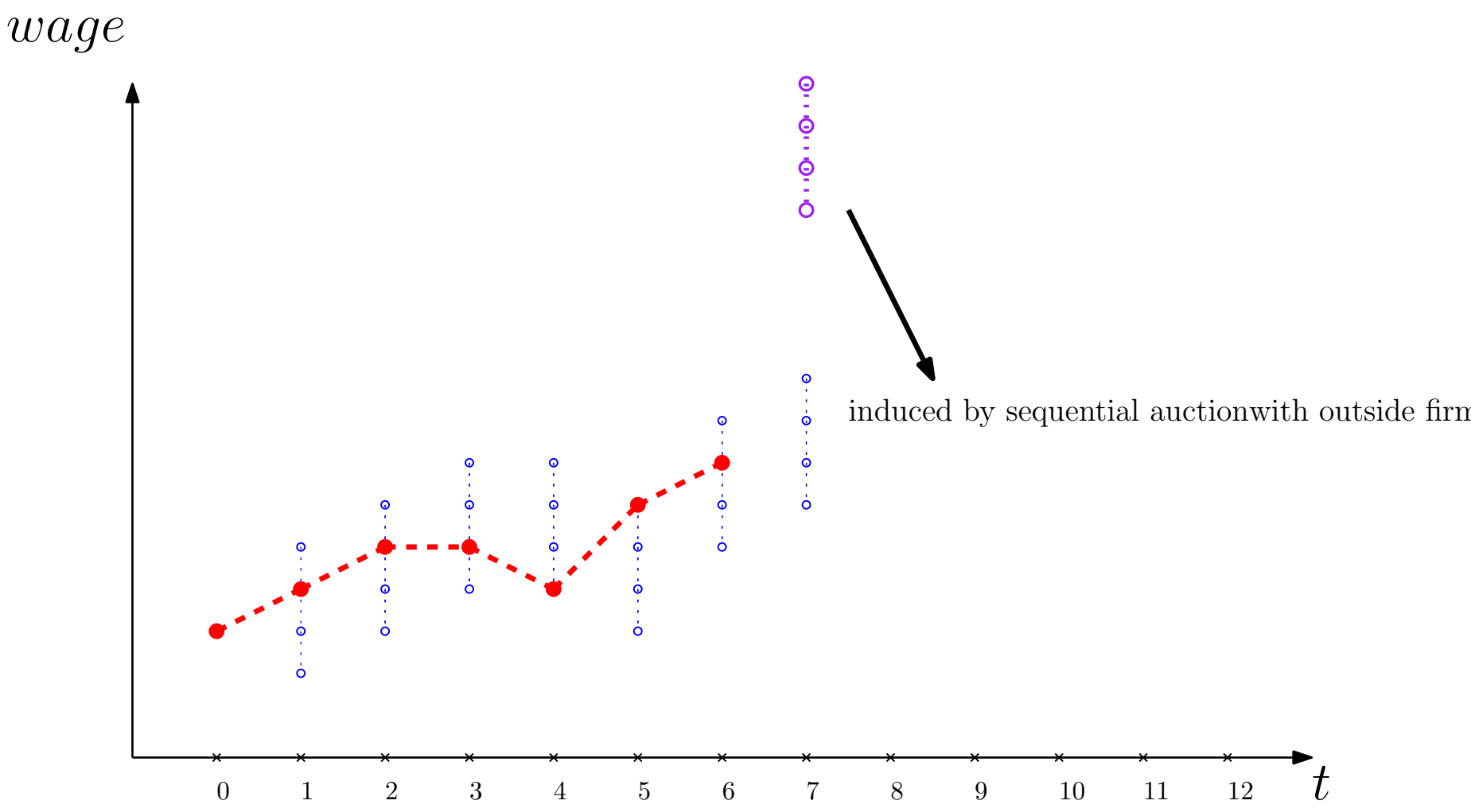

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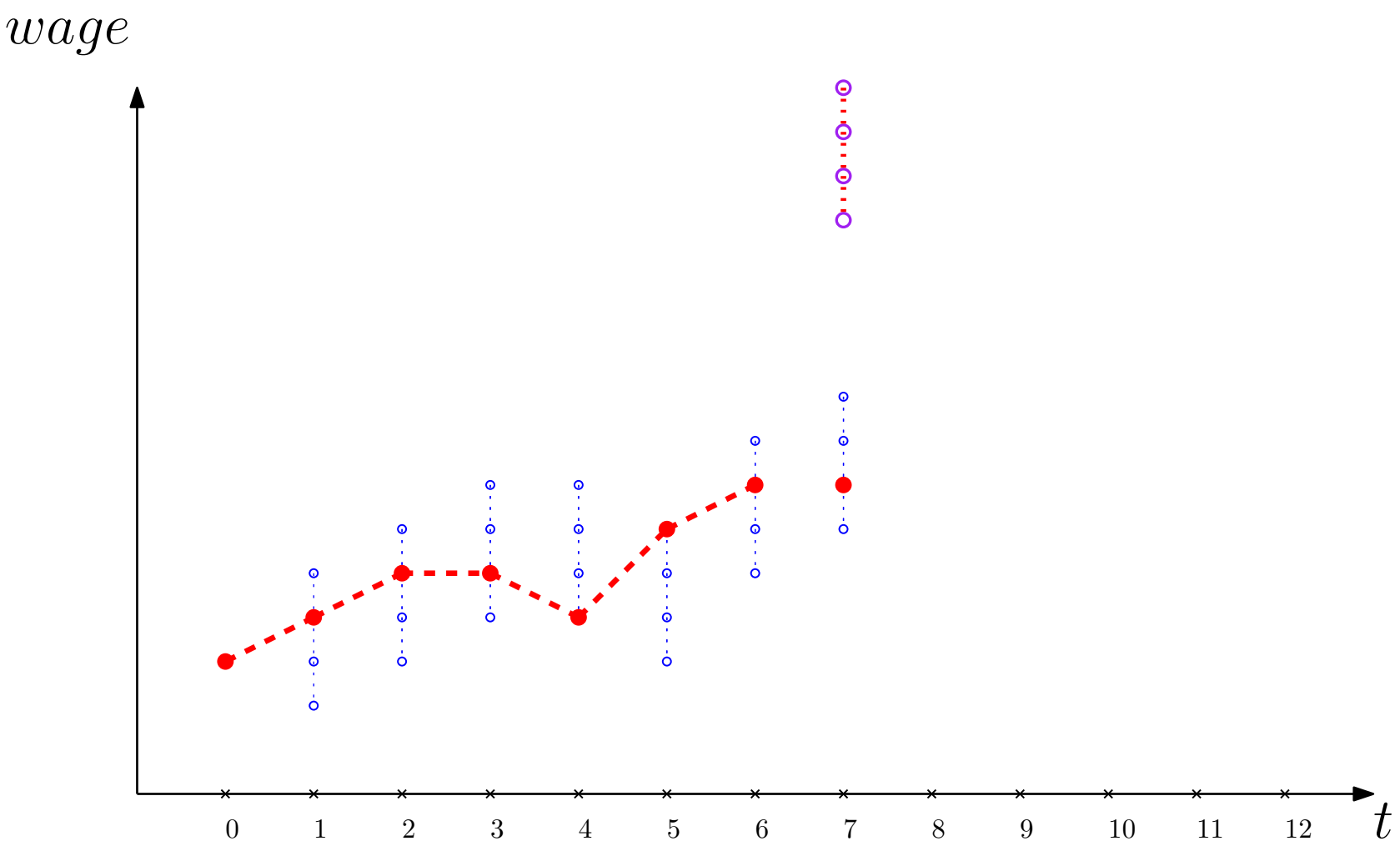

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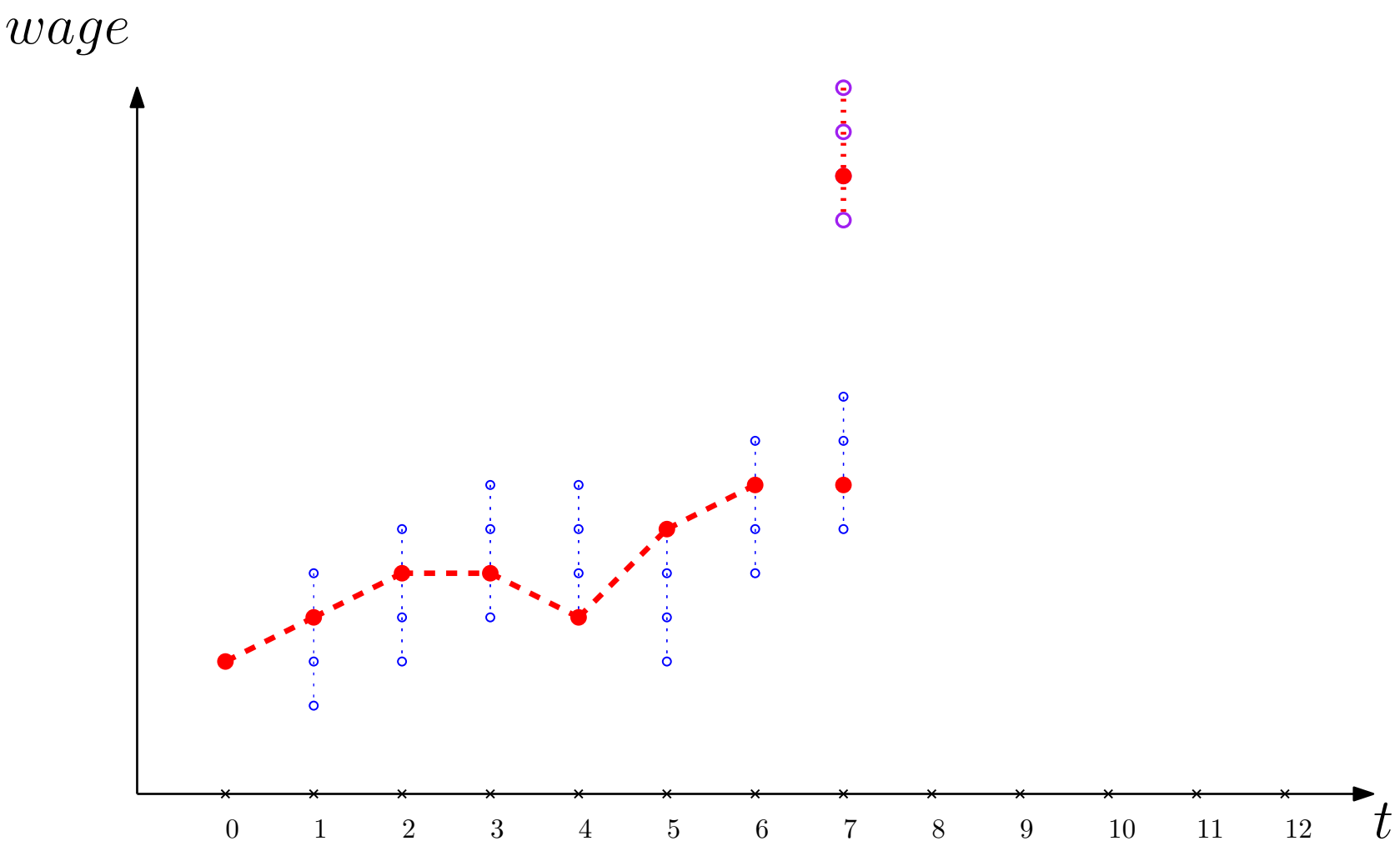

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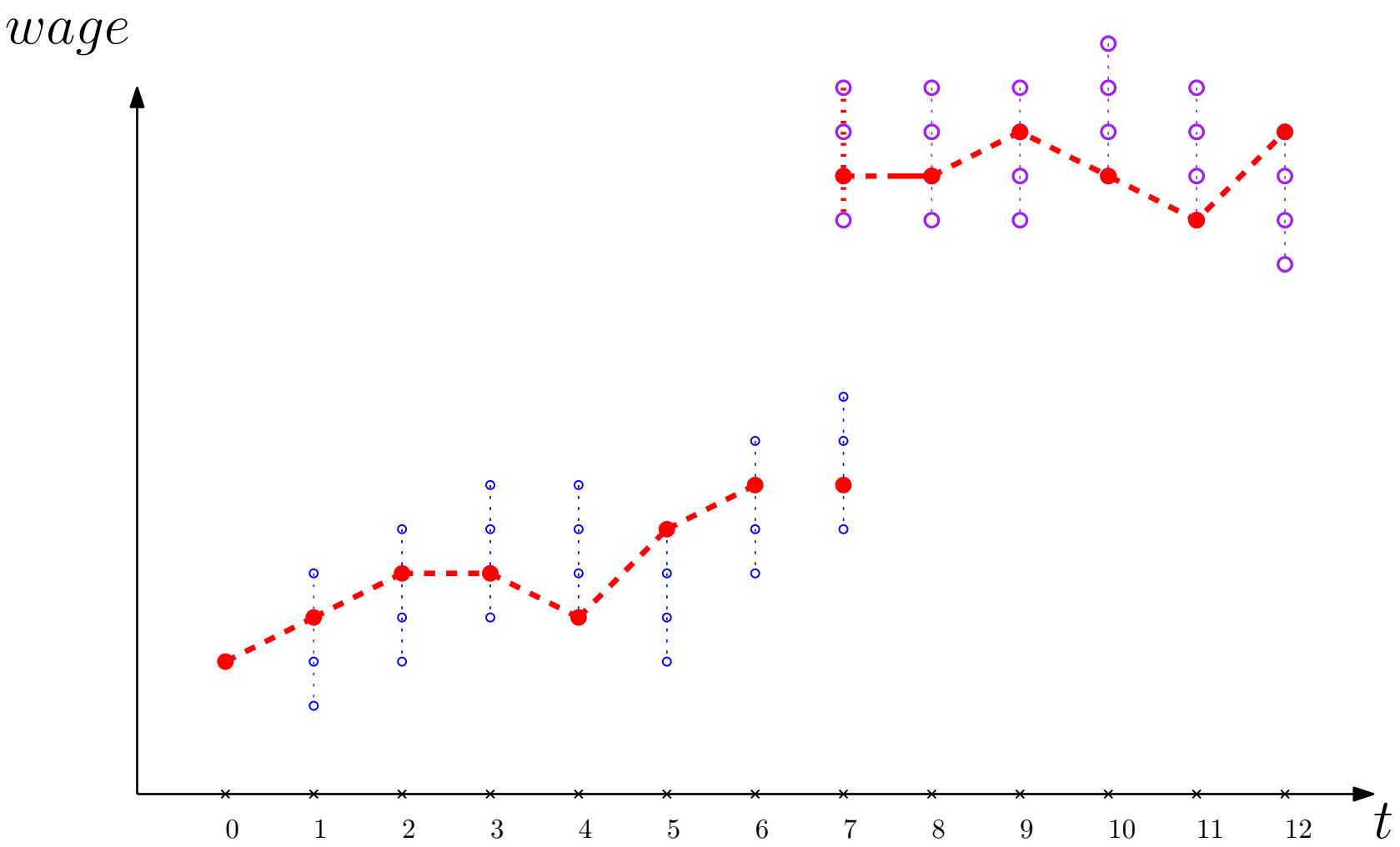

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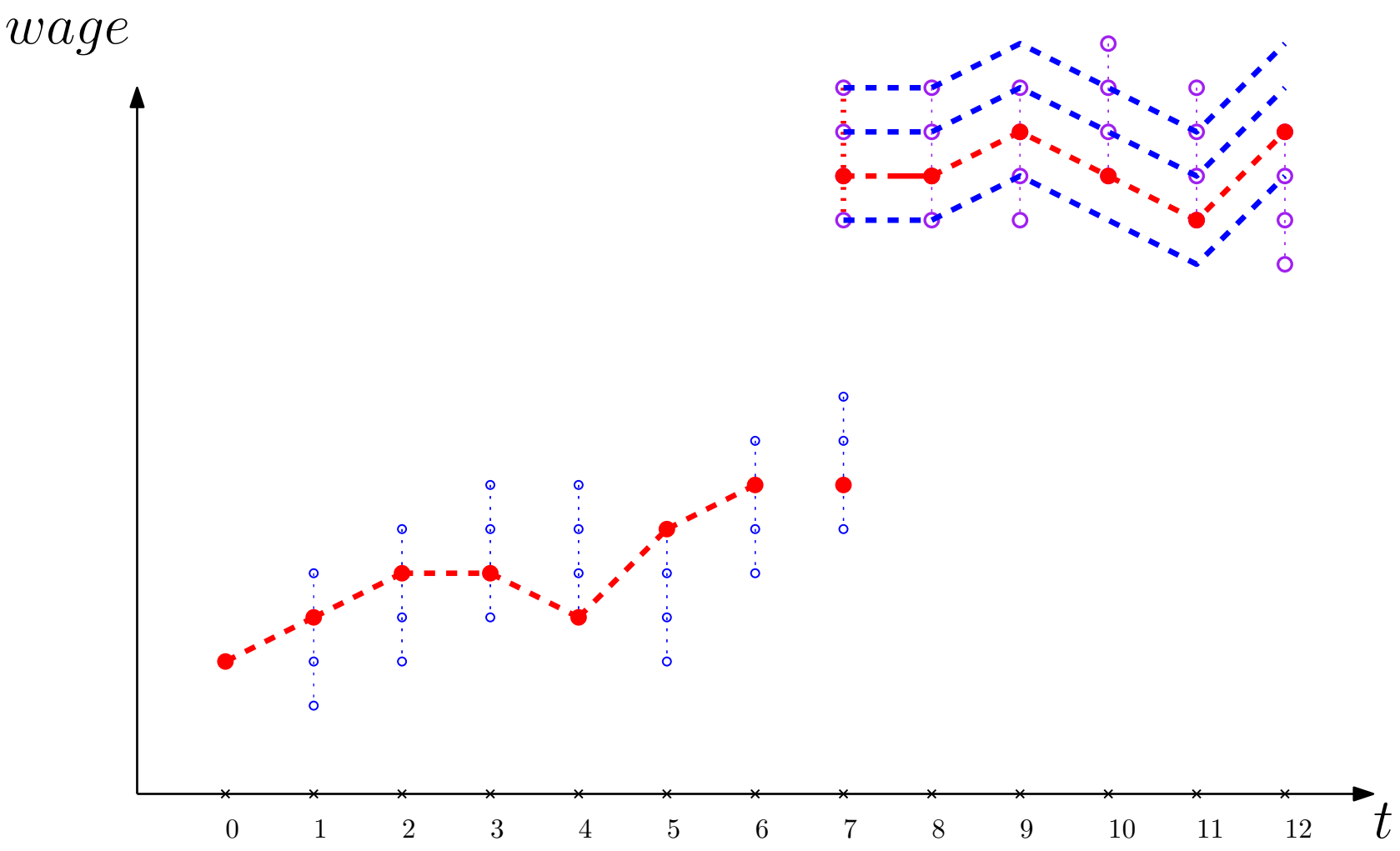
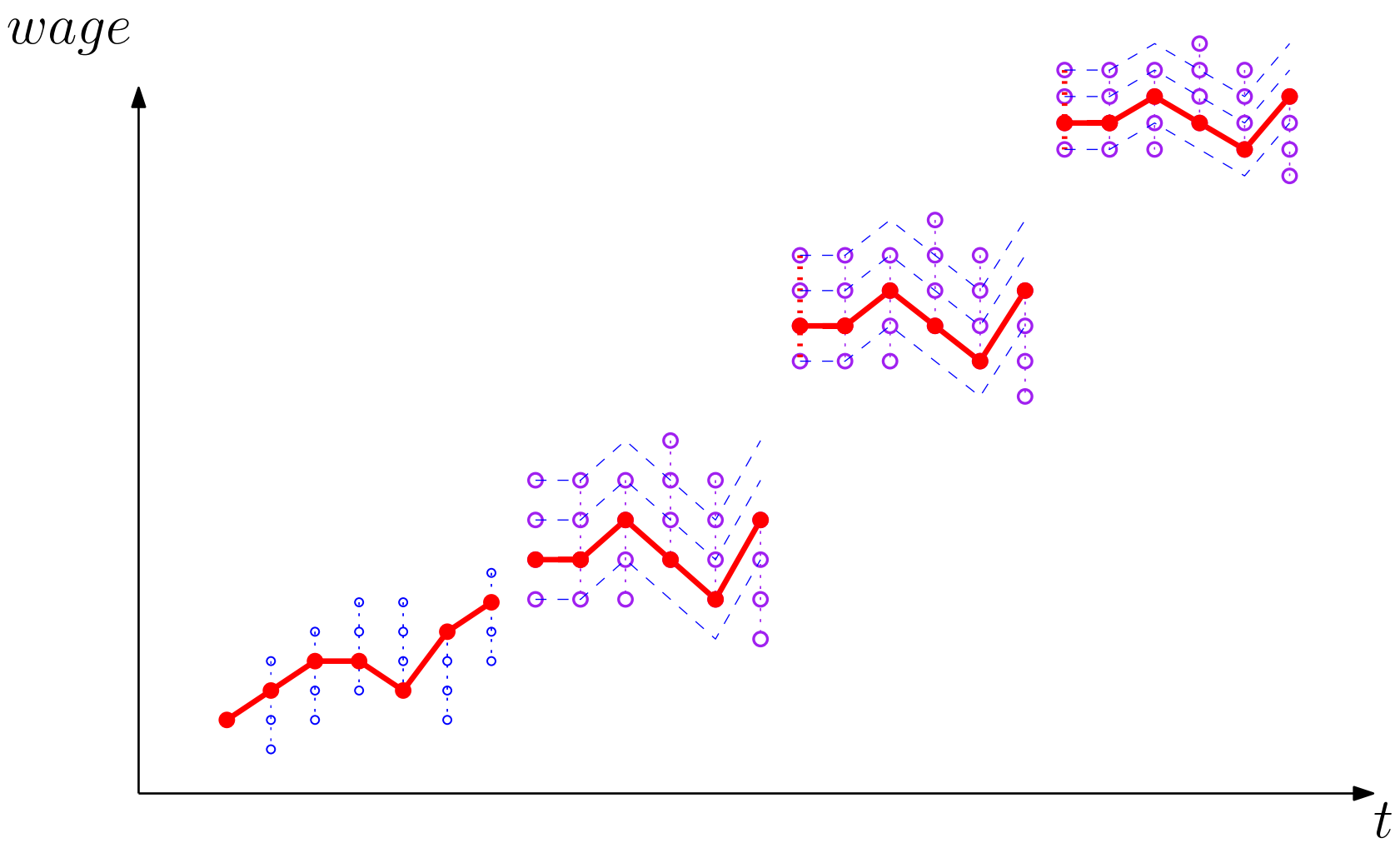
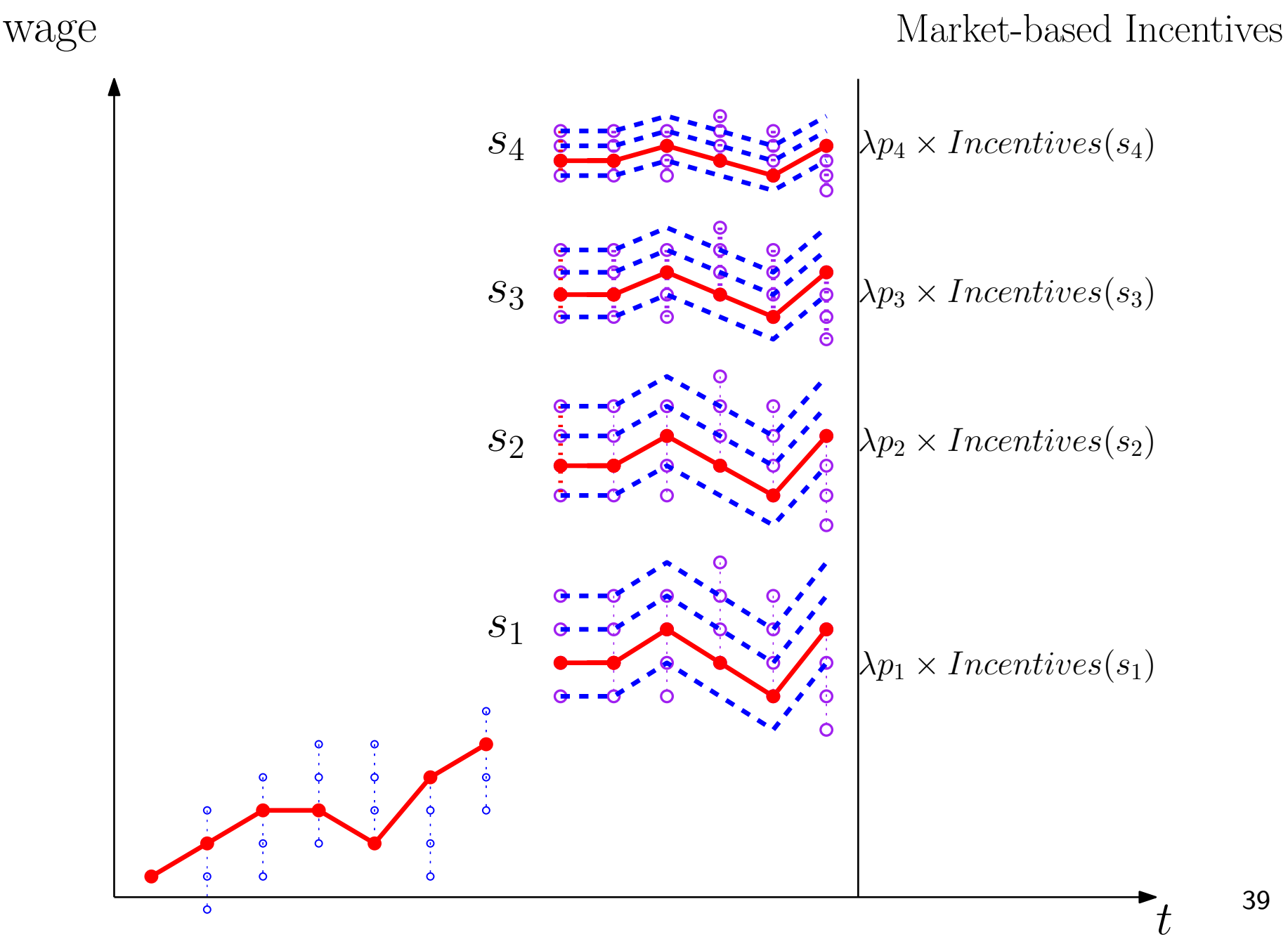


# Job Ladder



# Market-based Incentives

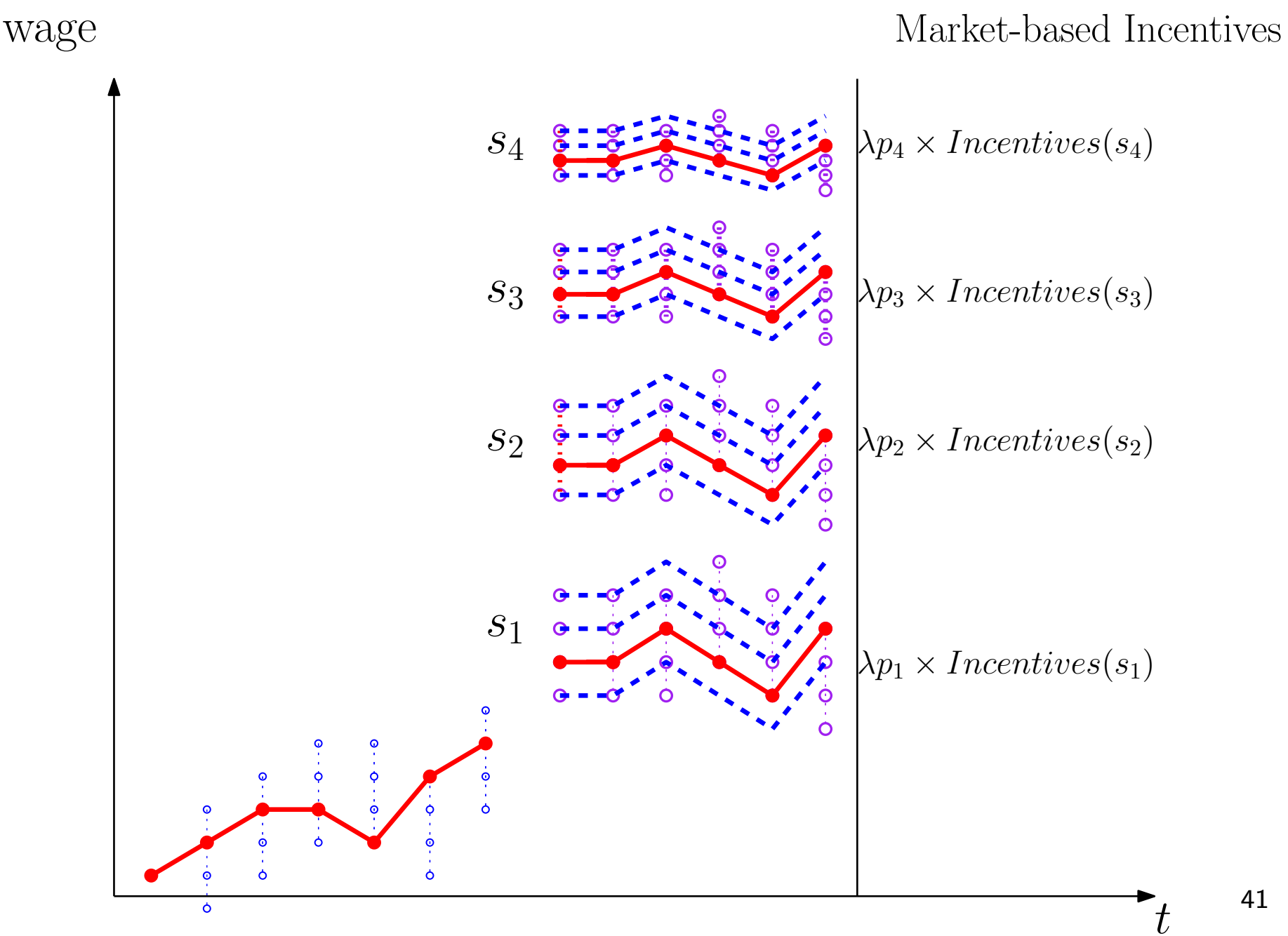


# Thought Experiment

Comparing the market-based incentives between two executives working in firms

$$s_2 < s_3$$

# Market-based Incentives



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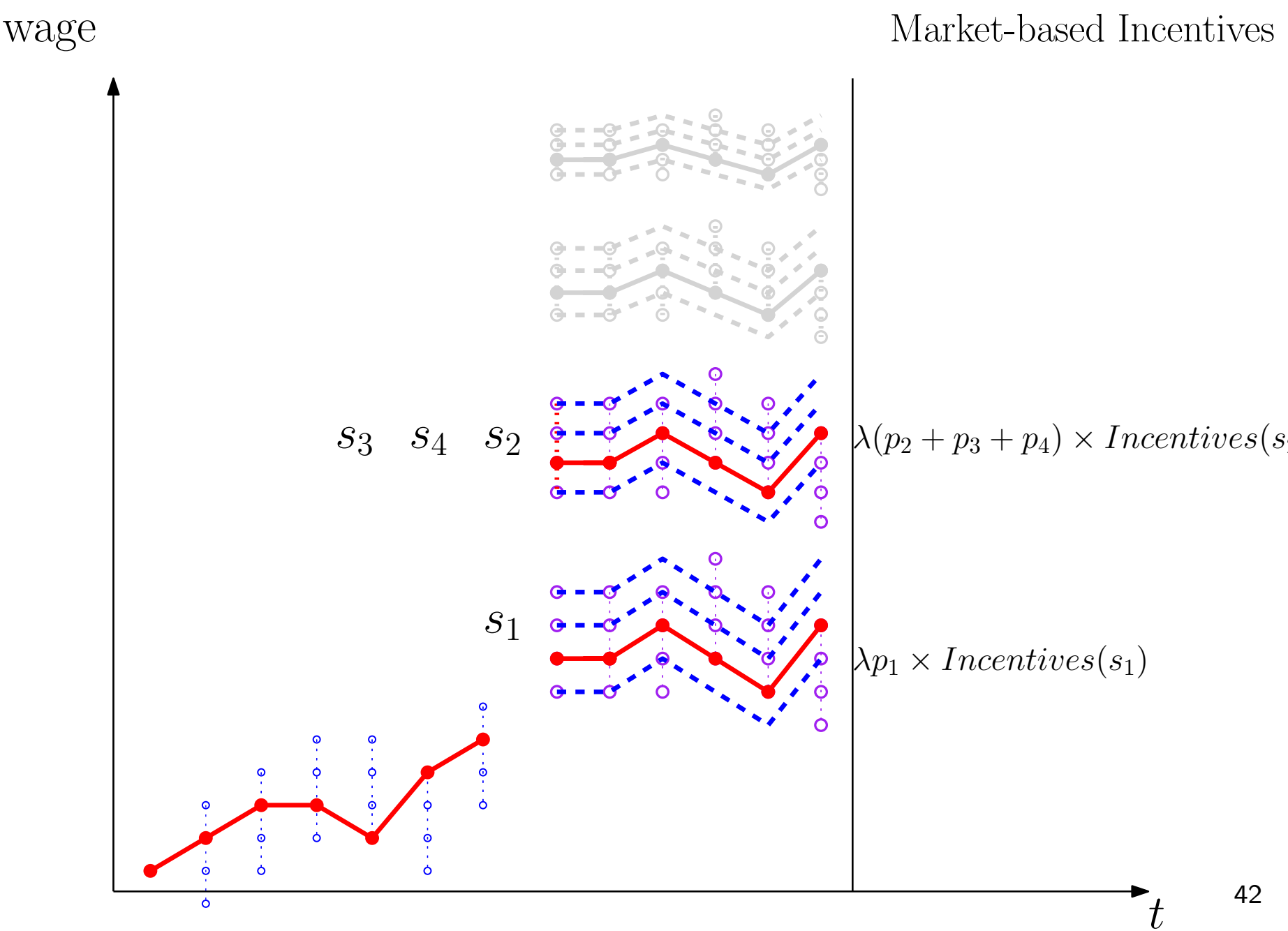

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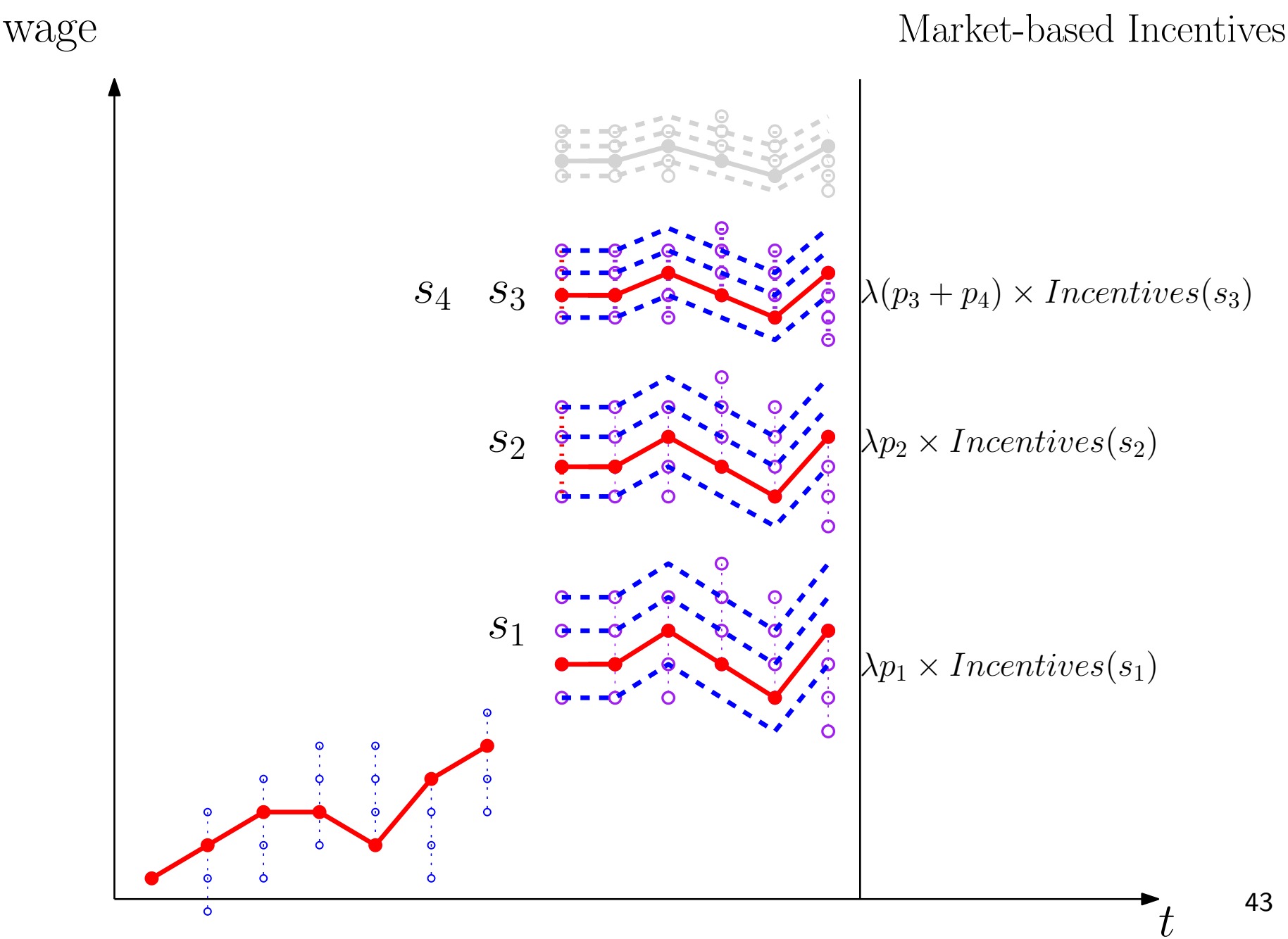


# Market-based incentives

**Proposition**

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

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

**Intuition**

Market competition raises the overall compensation level, which by diminishing marginal utility makes the executive less sensitive to market incentives.

# Estimation

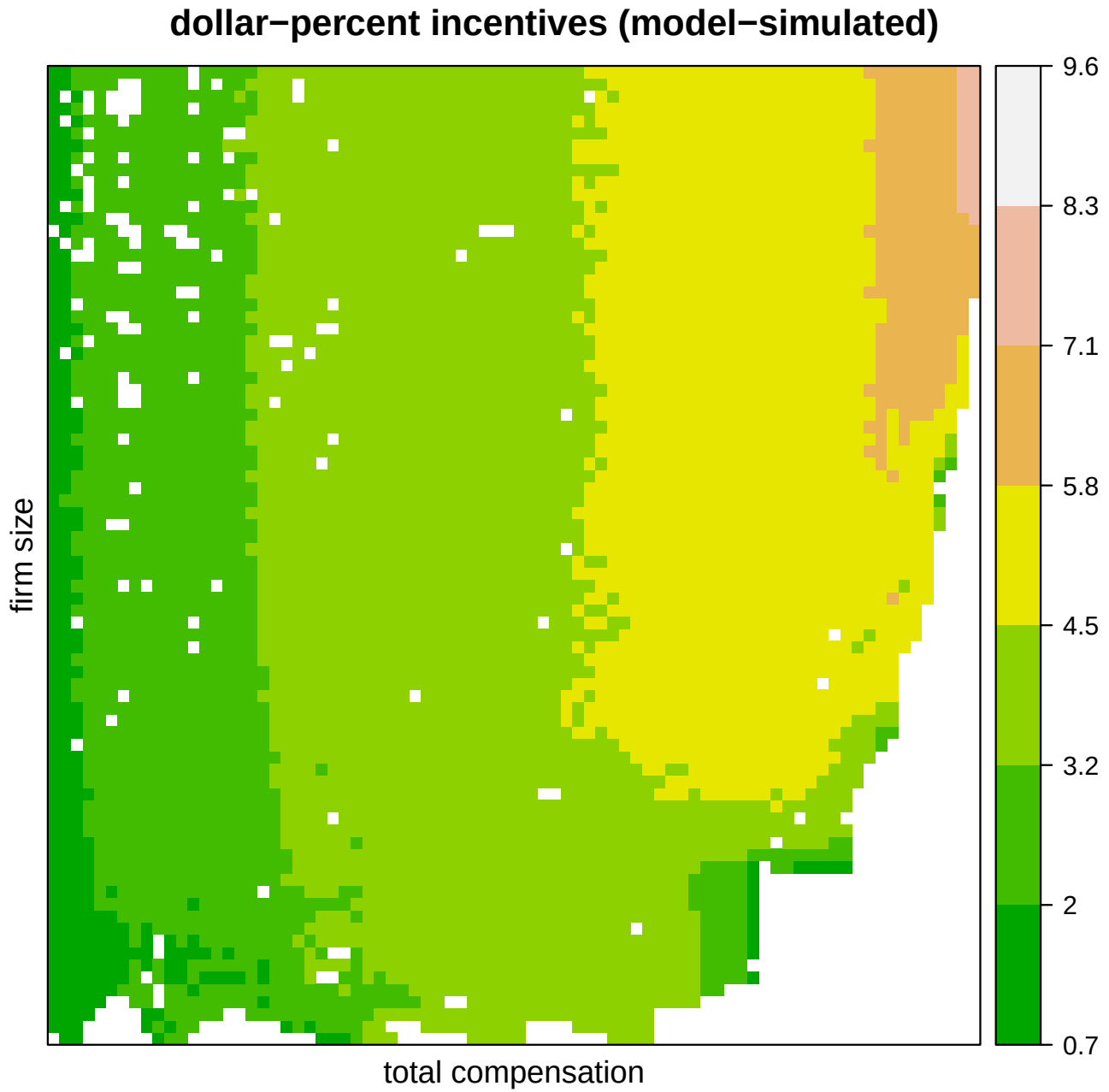
# Identification

- Parameters of exogenous processes, e.g. the executives' productivities, the exit rate and the offer arrival rate. There are direct links between the model and the data.
- Parameters on job offer distribution are informed by the correlation between firm size and total compensation.
- Parameters on moral hazard problem are infomed by log(*delta*) and the correlation with firm size and total compensation.

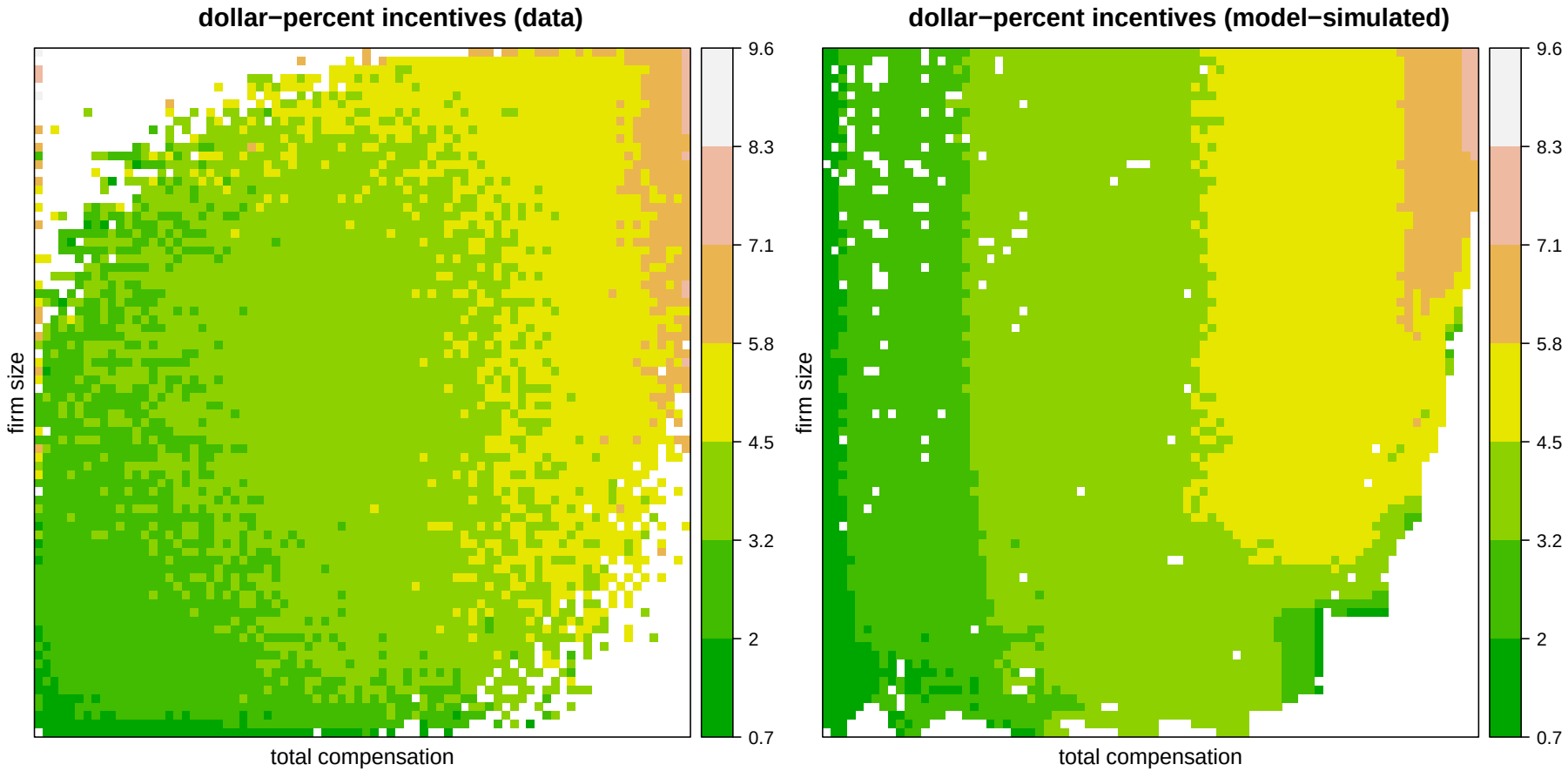
# Moments and Estimation

| 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



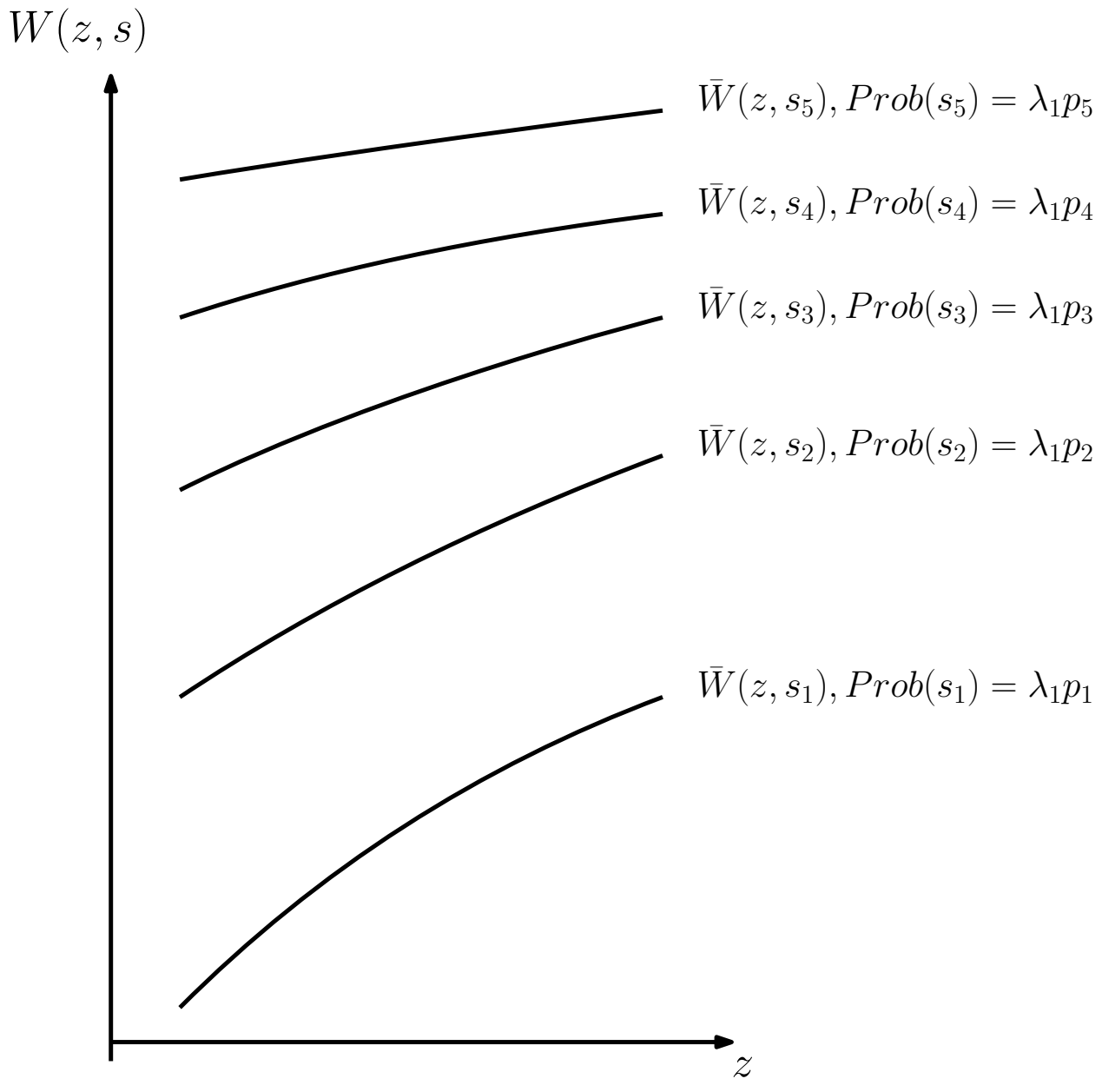
# Conclusion

# Summary

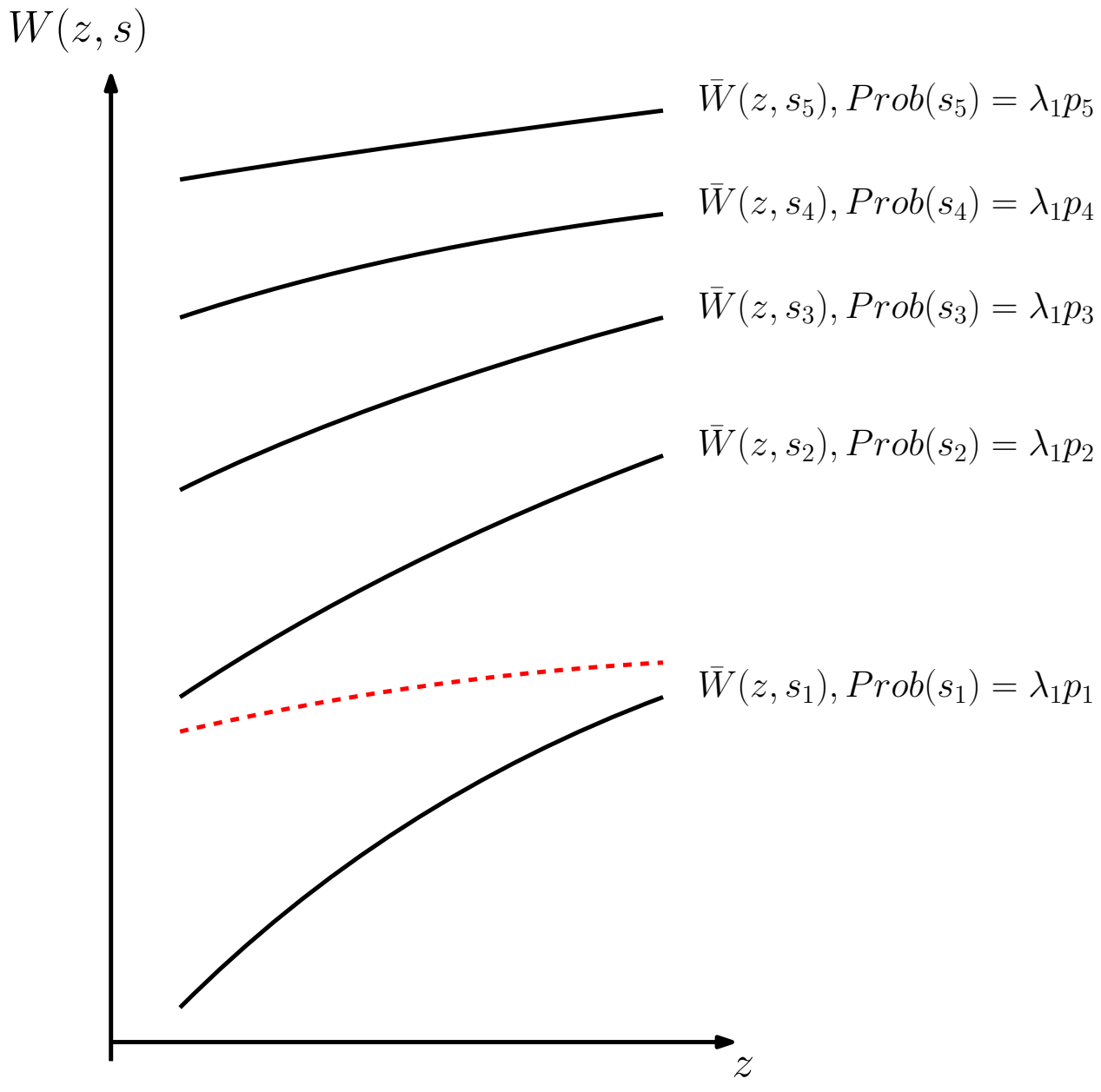
- Executives are motivated by `performance-based incentives` and `market-based incentives`.
- `Market-based incentives` are smaller in larger firms, so larger firms need more performance-based pay.
- The model can fit the size premium very well and generate the reasonable `delta` over firm size and total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

# Questions?

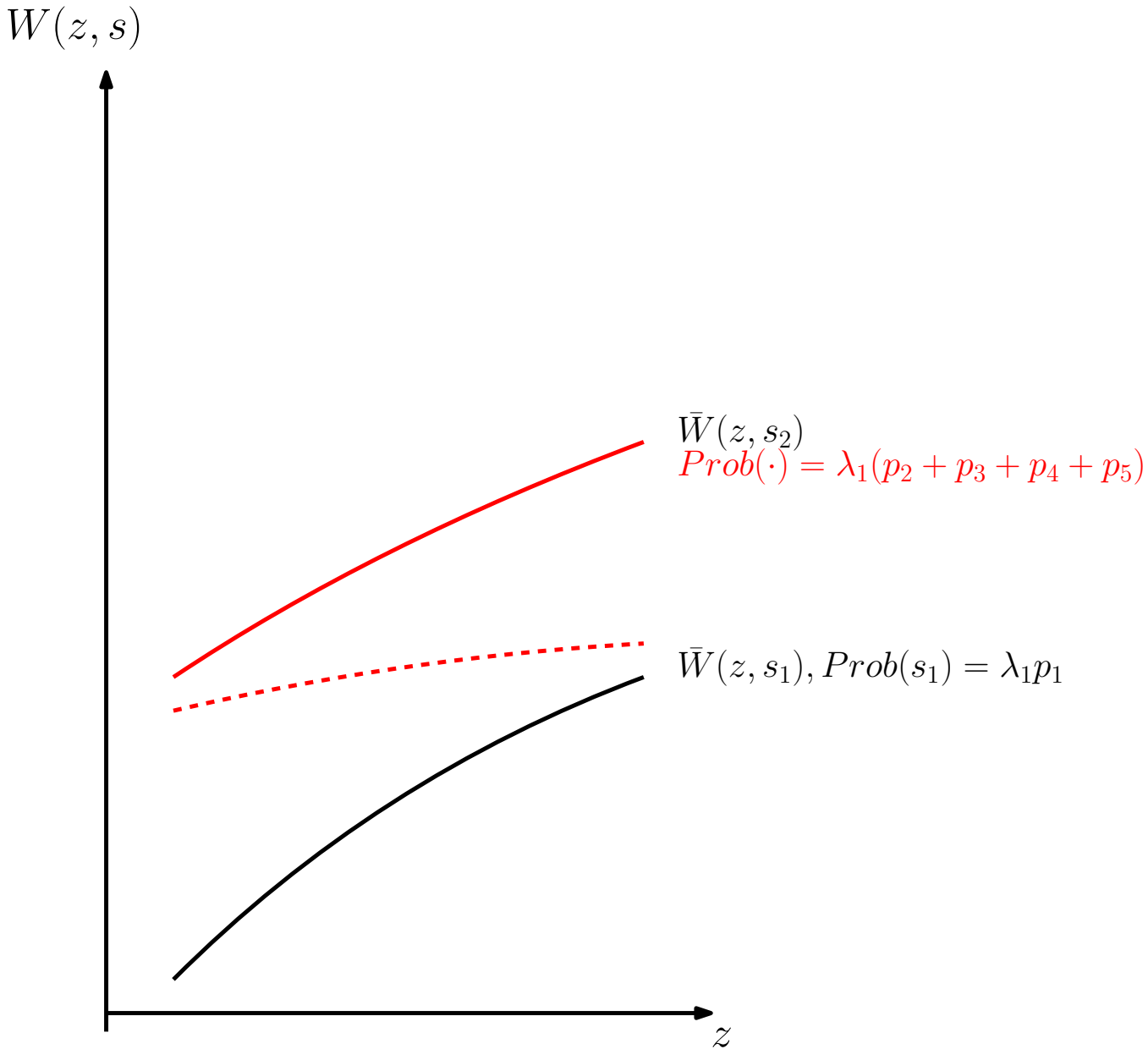
# Bidding frontier is more flat as firm becomes larger



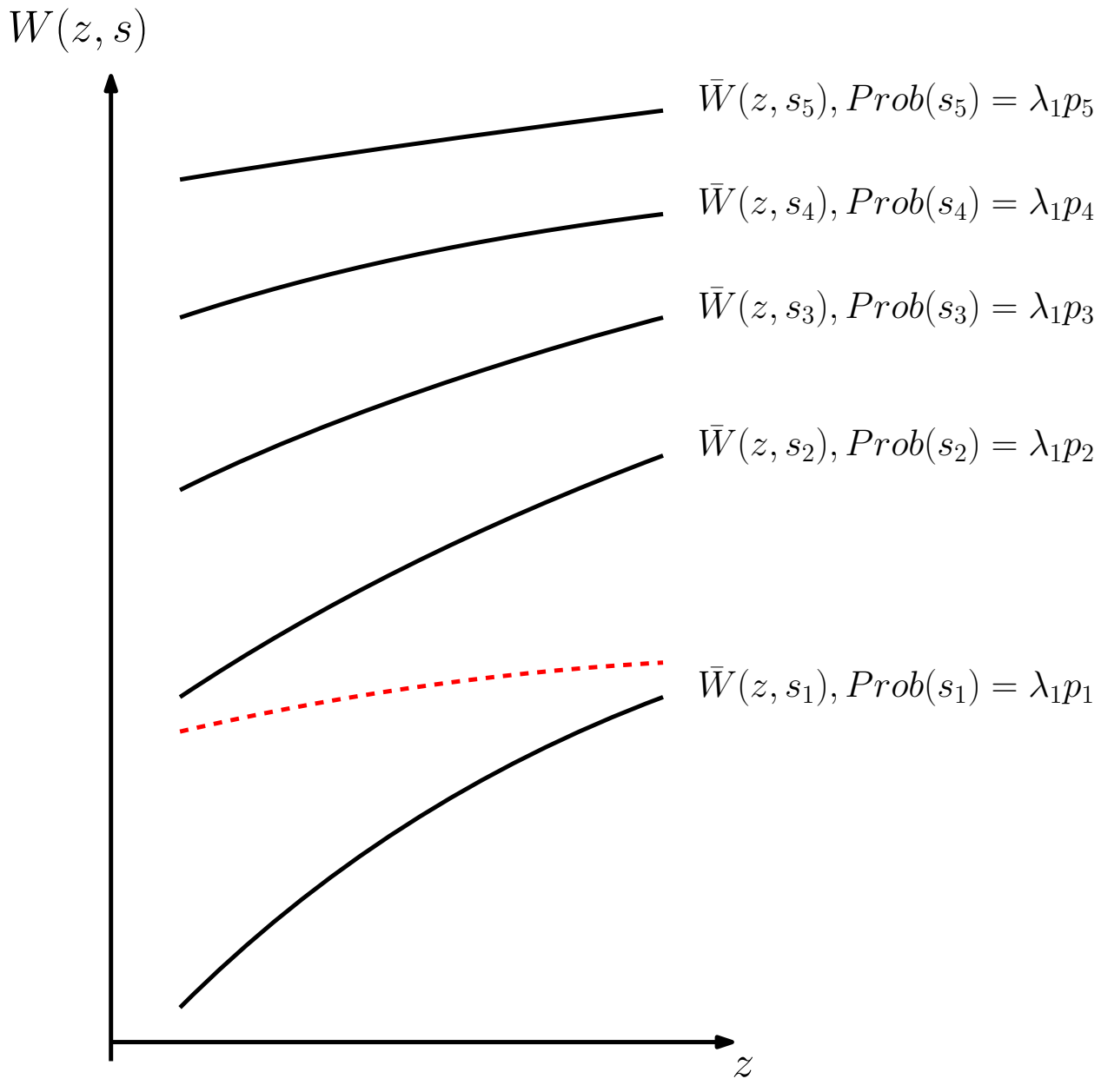
# Market-based incentives for executive in firm $s_2$



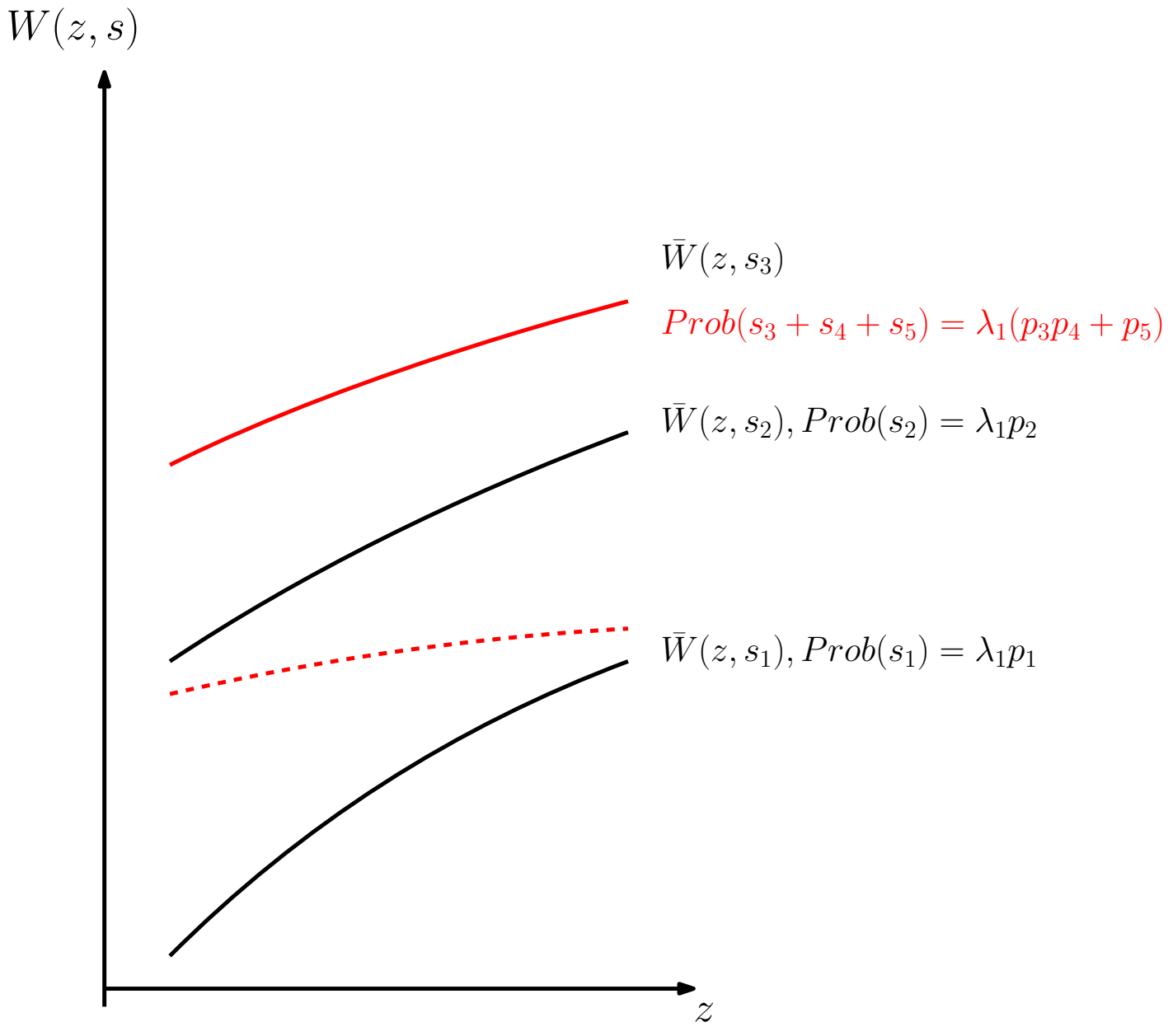
# Market-based incentives for executive in firm $s_2$



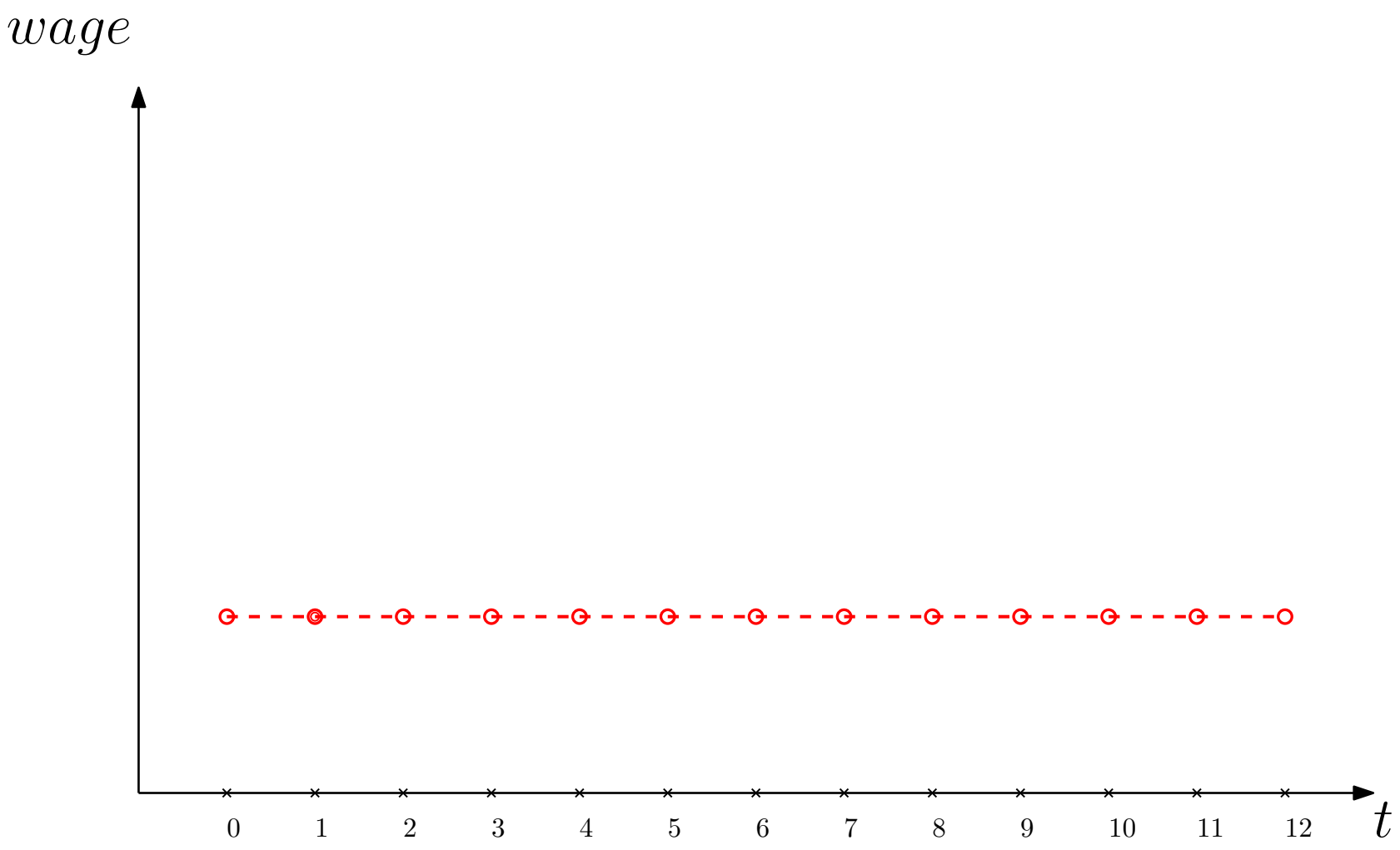
# Market-based incentives for executive in firm $s_3$



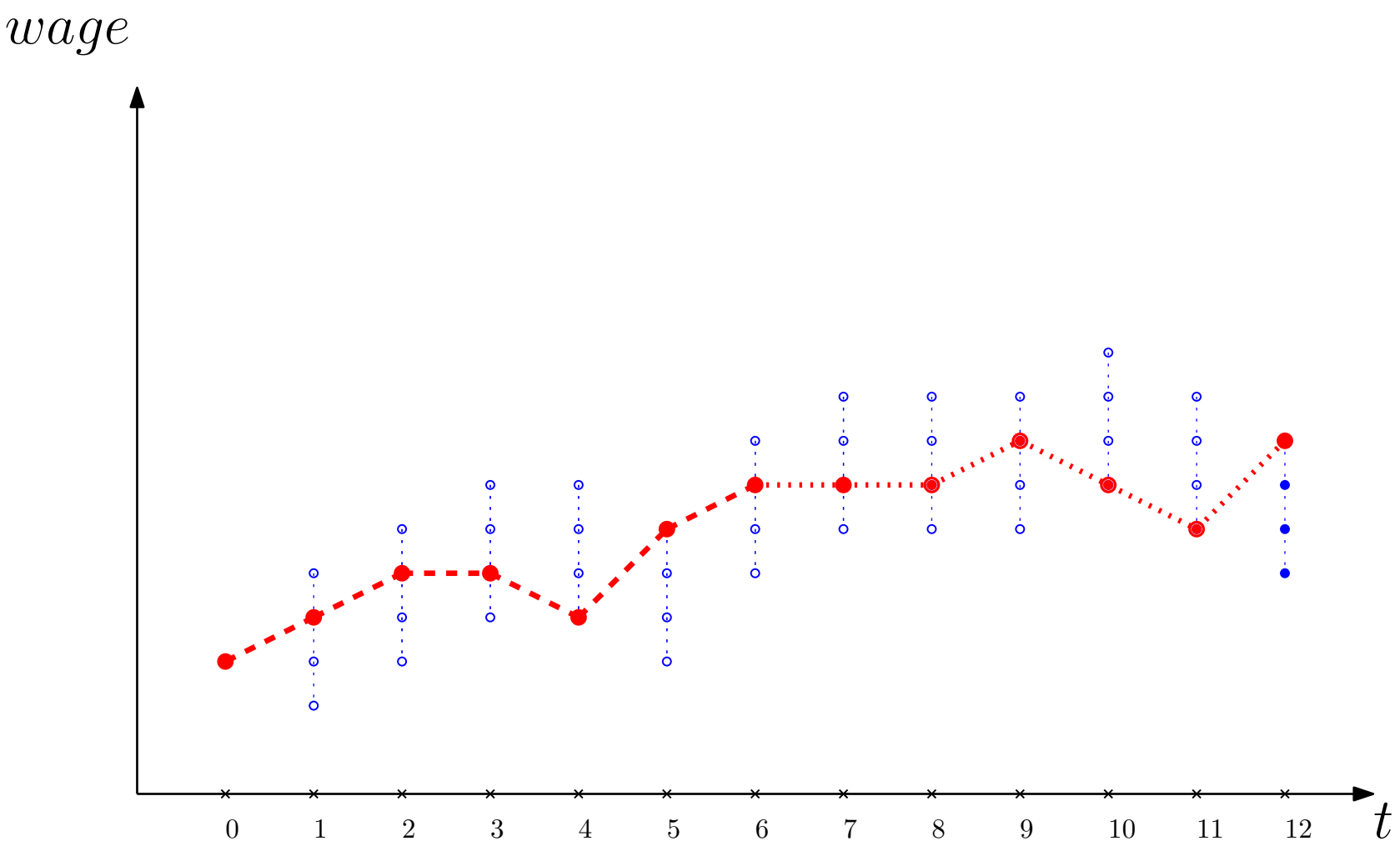
# Market-based incentives for executive in firm $s_3$



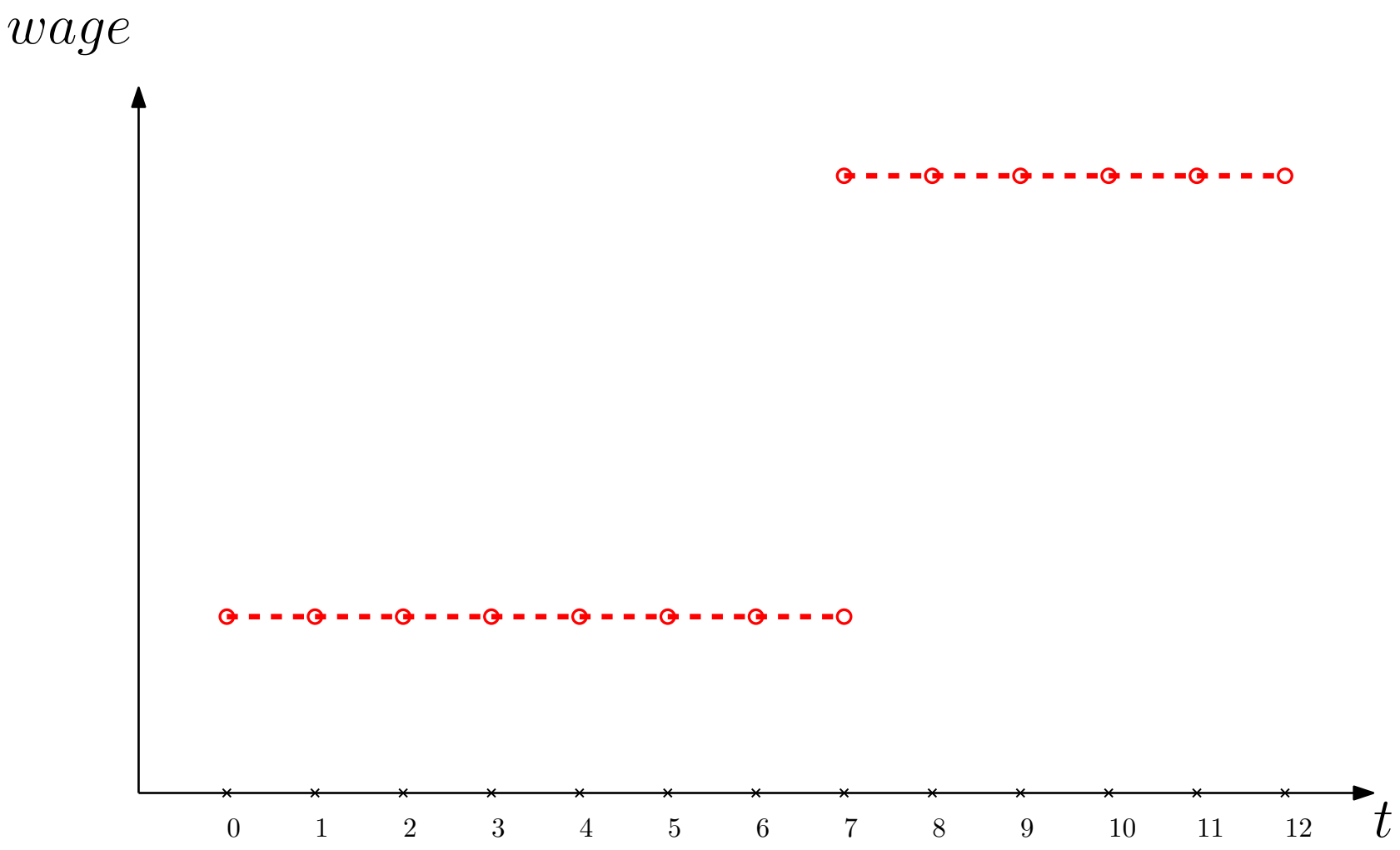
# No Moral Hazard, Full Commitment



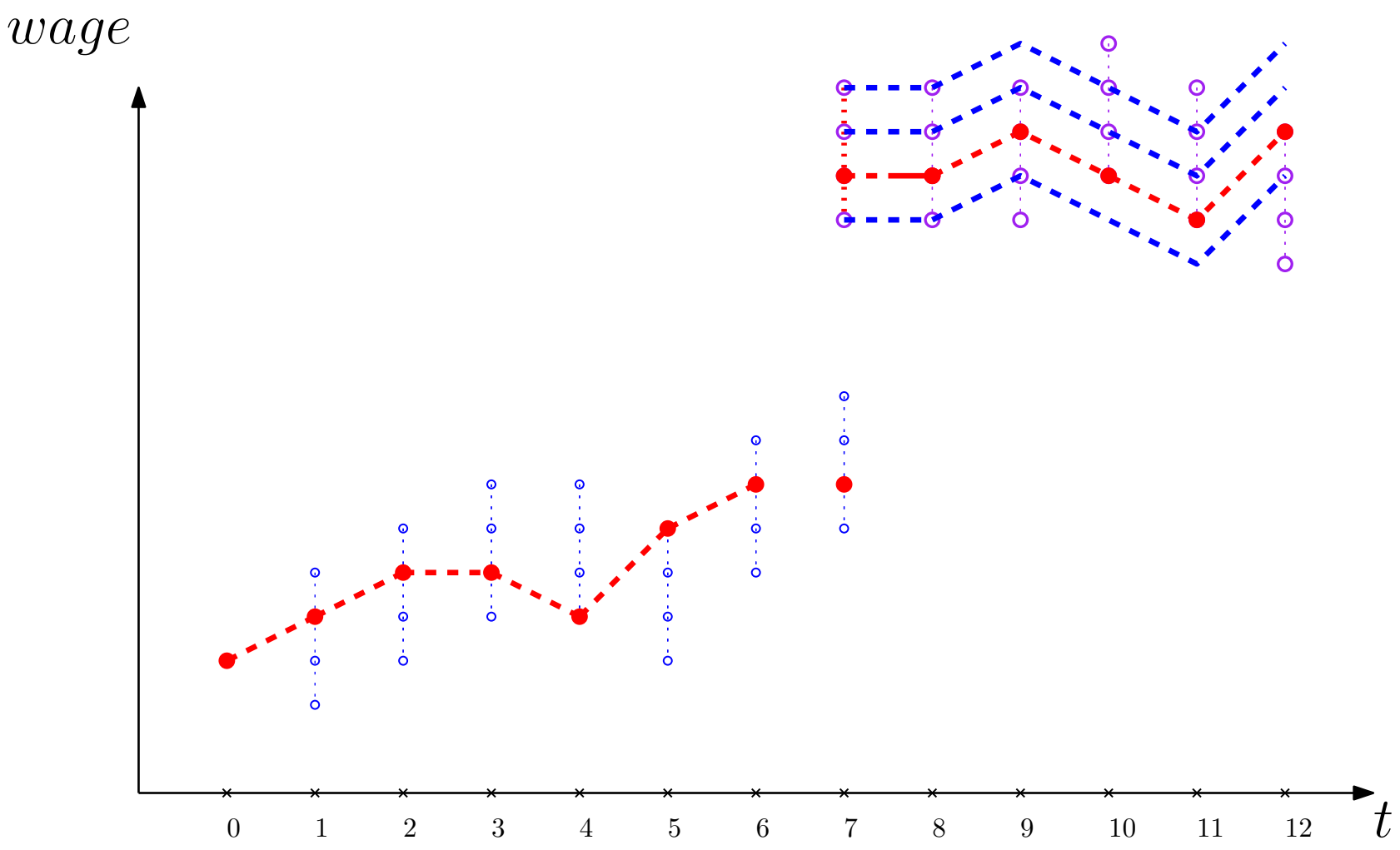
# Only Moral Hazard



# Only Limited Commitment



# Optimal Contract



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 |