Andreas Krause



Chapter 15.2 Remuneration of traders

Problem and assumptions	Independent traders	Fixed wages 000000	Performance wages	Optimal remuneration	Summary 0000
Outline					

- Problem and model assumptions
- Independent traders
- Fixed wages
- Performance wages
- Optimal trader remuneration

### Summary

Problem and assumptions         Independent traders         Fixed wages         Performance wages         Optimal remuneration         Summar           ●000         000         0000	Problem and assumptions ●000	Independent traders		Performance wages	Optimal remuneration	Summary 0000
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### Problem and model assumptions

Independent traders

### Fixed wages

Performance wages

Optimal trader remuneration

### Summary

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Problem and assumptions		Performance wages	Optimal remuneration	
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Problem and assumptions ○●○○	Independent traders 000	Fixed wages 000000	Performance wages	Optimal remuneration	Summary 0000

Investment banks' trading desks employ traders

Problem and assumptions	Independent traders	Fixed wages 000000	Performance wages	Optimal remuneration	Summary 0000

Investment banks' trading desks employ traders, who require remuneration

Problem and assumptions ○●○○	Independent traders	Fixed wages 000000	Performance wages	Optimal remuneration	Summary 0000

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Traders can be informed or uninformed

Problem and assumptions ○●○○	Independent traders	Fixed wages 000000	Performance wages	Optimal remuneration	Summary 0000

- Investment banks' trading desks employ traders, who require remuneration
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- Noise traders trade for exogenous reasons

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Price setting					

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### Problem and model assumptions

### Independent traders

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Problem and assumptions	Independent traders ○●○	Fixed wages 000000	Performance wages	Optimal remuneration	Summary 0000

# Trader profits

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Problem and assumptions	Independent traders ○●○	Fixed wages 000000	Performance wages	Optimal remuneration	Summary 0000
Trader profits					

► A trader not employed by an investment bank can trade independently

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Trader profits					

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- A trader not employed by an investment bank can trade independently and faces a trading fee f
- If the trader is uninformed he will not trade

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- ► Trading profits:  $\Pi_T = E\left[\left(\Delta V (1+f)\Delta P\right)Q_I|\Delta V\right] = \left(\Delta V (1+f)\lambda Q_I\right)Q_I$

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Problem and assumptions	Independent traders ○○●	Fixed wages 000000	Performance wages	Optimal remuneration	Summary 0000
Optimal deman	d				

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► Traders will maximize their profits with first order condition  $\frac{\partial \Pi_I}{\partial Q_I} = 0$ 

• Optimal demand: 
$$Q_I = \frac{\Delta V}{2(1+f)\lambda}$$

• Profits:  $E[\Pi_T] = \frac{\sigma_V^2}{4(1+f)\lambda}$ 

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Problem and model assumptions

Independent traders

#### Fixed wages

Performance wages

Optimal trader remuneration

#### Summary

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Problem and assumptions	Independent traders	Fixed wages 00●000	Performance wages	Optimal remuneration	Summary 0000
Total demand					

# ► If an informed trader is not employed, he will demand $\hat{Q}_I = \frac{\Delta V}{2(1+f)\lambda}$

Problem and assumptions	Independent traders	Fixed wages 00●000	Performance wages	Optimal remuneration	Summary 0000

- ▶ If an informed trader is not employed, he will demand  $\hat{Q}_I = \frac{\Delta V}{2(1+f)\lambda}$
- Trading demand arises if the informed trader is employed

Problem and assumptions	Independent traders	Fixed wages 00●000	Performance wages	Optimal remuneration	Summary 0000

- ► If an informed trader is not employed, he will demand  $\hat{Q}_I = \frac{\Delta V}{2(1+f)\lambda}$
- Trading demand arises if the informed trader is employed, or the uninformed trader is employed
- $\blacktriangleright D = \gamma Q_I + (1 \gamma) \left( Q_U \right)$

Problem and assumptions	Independent traders 000	Fixed wages 00●000	Performance wages	Optimal remuneration	Summary 0000

- ▶ If an informed trader is not employed, he will demand  $\hat{Q}_I = \frac{\Delta V}{2(1+f)\lambda}$
- Trading demand arises if the informed trader is employed, or the uninformed trader is employed, with the informed trader acting independently
- $\blacktriangleright D = \gamma Q_I + (1 \gamma) \left( Q_U + \hat{Q}_I \right)$

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- ▶ If an informed trader is not employed, he will demand  $\hat{Q}_I = \frac{\Delta V}{2(1+f)\lambda}$
- Trading demand arises if the informed trader is employed, or the uninformed trader is employed, with the informed trader acting independently, plus noise traders
- $\blacktriangleright D = \gamma Q_I + (1 \gamma) \left( Q_U + \hat{Q}_I \right) + U$

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$$\blacktriangleright D = \gamma Q_I + (1 - \gamma) \left( Q_U + \hat{Q}_I \right) + U$$

Problem and assumptions         Independent traders         Fixed wages         Performance wages         Optimal remuneration         Summary           00000	Problem and assumptions	Independent traders	Fixed wages 000●00	Performance wages	Optimal remuneration	Summary 0000
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# Equilibrium pricing

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Problem and assumptions	Independent traders	Fixed wages 000●00	Performance wages	Optimal remuneration	Summary 0000
Equilibrium pr	icing				

Uniformed traders cannot infer security values

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Equilibrium pric	cing				

• Uniformed traders cannot infer security values:  $Cov \left[\Delta V, \Delta \hat{V}\right] = 0$  and  $Var \left[\Delta V\right] = Var \left[\Delta \hat{V}\right]$ 

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- They will trade randomly giving the impression having received ΔÛ
   This gives Cov [ΔV, D] = σ<sub>V</sub><sup>2</sup>(1+γf)/2(1+f)λ and Var [D] = σ<sub>V</sub><sup>2</sup>(1+γf)<sup>2</sup>/4(1+f)<sup>2</sup>λ<sup>2</sup> + (1-γ)<sup>2</sup>/4λ<sup>2</sup> + σ<sub>U</sub><sup>2</sup>

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- Solving for  $\lambda = \frac{1}{2} \frac{\sigma_V}{\sigma_U} \sqrt{2 \frac{1+\gamma f}{1+f} \left(\frac{1+\gamma f}{1+f}\right)^2 (1-\gamma)^2}$

Problem and assumptions	Independent traders	Fixed wages 000●00	Performance wages	Optimal remuneration	Summary 0000

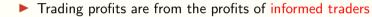
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   Solving for λ = ½ σ<sub>U</sub>/σ<sub>U</sub> √(2 1+γf)/(1+f) ((1+γf)/(1+f))<sup>2</sup> (1-γ)<sup>2</sup>)

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Problem and assumptions	Independent traders	Fixed wages 0000●0	Performance wages	Optimal remuneration	Summary 0000



Problem and assumptions	Independent traders	Fixed wages 0000●0	Performance wages	Optimal remuneration	Summary 0000

- Trading profits are from the profits of informed traders and losses of uniformed traders
- $= \gamma E \left[ \left( \Delta V \Delta P \right) Q_I | \Delta V \right] + \left( 1 \gamma \right) E \left[ \left( \Delta V \Delta P \right) Q_U \right]$

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Trading profits are from the profits of informed traders and losses of uniformed traders

$$\Pi = \gamma E \left[ (\Delta V - \Delta P) Q_I | \Delta V \right] + (1 - \gamma) E \left[ (\Delta V - \Delta P) Q_U \right]$$

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• Profits:  $\Pi_B = E[\Pi] - w = \left(\gamma - \frac{1}{2}\frac{2+f}{1+f}\right) \frac{\sigma_U \sigma_V}{\sqrt{2\frac{1+\gamma f}{1+f} - \left(\frac{1+\gamma f}{1+f}\right)^2 - (1-\gamma)^2}}$ 

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- We need sufficient informed traders that trade profitably to ensure the losses made by uninformed traders are covered
- ▶ For reasonably low trading costs *f*, this threshold is very high

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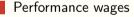
- ▶ Investment banks will only operate a trading desk if  $\Pi_B \ge 0$
- This requires  $\gamma \geq \frac{1}{2} \frac{2+f}{1+f}$
- We need sufficient informed traders that trade profitably to ensure the losses made by uninformed traders are covered
- For reasonably low trading costs f, this threshold is very high

	Problem and assumptions	Independent traders	Fixed wages 000000	Performance wages ●000	Optimal remuneration	Summary 0000
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Problem and model assumptions

Independent traders

Fixed wages



Optimal trader remuneration

#### Summary

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Problem and assumptions	Independent traders	Fixed wages 000000	Performance wages 0●00	Optimal remuneration	Summary 0000

# Total demand

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Problem and assumptions	Independent traders	Fixed wages 000000	Performance wages ○●○○	Optimal remuneration	Summary 0000
Total demand					

Investment banks will only pay traders according to the profits they make

Problem and assumptions	Independent traders	Fixed wages 000000	Performance wages ○●○○	Optimal remuneration	Summary 0000
Total demand					

- Investment banks will only pay traders according to the profits they make
- Informed traders will receive a schedule that induces them to join the investment bank

Problem and assumptions	Independent traders	Fixed wages 000000	Performance wages ○●○○	Optimal remuneration	Summary 0000
Total demand					

- Investment banks will only pay traders according to the profits they make
- Informed traders will receive a schedule that induces them to join the investment bank
- Uniformed traders will not trade as they make losses

Problem and assumptions	Independent traders	Fixed wages 000000	Performance wages ○●○○	Optimal remuneration	Summary 0000
Total demand					

- Investment banks will only pay traders according to the profits they make
- Informed traders will receive a schedule that induces them to join the investment bank
- Uniformed traders will not trade as they make losses
- ► Total demand is from the informed traders employed by the investment bank

Problem and assumptions	Independent traders 000	Fixed wages 000000	Performance wages ○●○○	Optimal remuneration	Summary 0000
Total demand					

- Investment banks will only pay traders according to the profits they make
- Informed traders will receive a schedule that induces them to join the investment bank
- Uniformed traders will not trade as they make losses
- Total demand is from the informed traders employed by the investment bank, informed traders not employed
- $\blacktriangleright D = \gamma Q_I + (1 \gamma) \hat{Q}_I$

Problem and assumptions	Independent traders	Fixed wages 000000	Performance wages ○●○○	Optimal remuneration	Summary 0000
Total demand					

- Investment banks will only pay traders according to the profits they make
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 $\blacktriangleright D = \gamma Q_I + (1 - \gamma) \hat{Q}_I + U$ 

Problem and assumptions	Independent traders	Fixed wages 000000	Performance wages ○●○○	Optimal remuneration	Summary 0000
Total domand					

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iolal demand

Problem and assumptions	Independent traders	Fixed wages 000000	Performance wages 00●0	Optimal remuneration	Summary 0000

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Problem and assumptions	Independent traders	Fixed wages 000000	Performance wages	Optimal remuneration	Summary 0000

• We get 
$$Cov [\Delta V, D] = \sigma_V^2 \frac{1+\gamma f}{2(1+f)\lambda}$$
 and  $Var [D] = \sigma_V^2 \frac{(1+\gamma f)^2}{4(1+f)^2\lambda^2} + \sigma_U^2$ 

Problem and assumptions	Independent traders	Fixed wages 000000	Performance wages 00●0	Optimal remuneration	Summary 0000

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 and  $Var [D] = \sigma_V^2 \frac{(1+\gamma f)^2}{4(1+f)^2\lambda^2} + \sigma_U^2$   
• Solving for  $\lambda = \frac{1}{2} \frac{\sigma_V}{\sigma_U} \frac{\sqrt{(1+\gamma f)(2(1+f)-(1+\gamma f))}}{1+f}$ 

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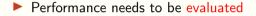
Problem and assumptions	Independent traders	Fixed wages 000000	Performance wages 00●0	Optimal remuneration	Summary 0000

Problem and assumptions	Independent traders	Fixed wages 000000	Performance wages 00●0	Optimal remuneration	Summary 0000

	Problem and assumptions	Independent traders	Fixed wages 000000	Performance wages 000●	Optimal remuneration	Summary 0000
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Problem and assumptions	Independent traders	Fixed wages 000000	Performance wages 000●	Optimal remuneration	Summary 0000



Problem and assumptions	Independent traders 000	Fixed wages	Performance wages 000●	Optimal remuneration	Summary 0000
Investment bar	nk profits				

Performance needs to be evaluated, this costs investment banks C

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Problem and assumptions	Independent traders	Fixed wages 000000	Performance wages 000●	Optimal remuneration	Summary 0000

- $\blacktriangleright$  Performance needs to be evaluated, this costs investment banks C
- Investment banks obtain trading profits

▶ Profits:  $\hat{\Pi}_B = E[\Pi]$ 

Problem and assumptions	Independent traders	Fixed wages	Performance wages 000●	Optimal remuneration	Summary 0000
	1 C'.				

- $\blacktriangleright$  Performance needs to be evaluated, this costs investment banks C
- Investment banks obtain trading profits, pay the wages to informed traders only
- ▶ Profits:  $\hat{\Pi}_B = E[\Pi] \gamma w$

Problem and assumptions	Independent traders	Fixed wages 000000	Performance wages 000●	Optimal remuneration	Summary 0000

- ▶ Performance needs to be evaluated, this costs investment banks C
- Investment banks obtain trading profits, pay the wages to informed traders only, and face costs of evaluating trader performance
- Profits:  $\hat{\Pi}_B = E[\Pi] \gamma w C$

Problem and assumptions	Independent traders	Fixed wages 000000	Performance wages 000●	Optimal remuneration	Summary 0000

- ▶ Performance needs to be evaluated, this costs investment banks C
- Investment banks obtain trading profits, pay the wages to informed traders only, and face costs of evaluating trader performance

• Profits: 
$$\hat{\Pi}_B = E[\Pi] - \gamma w - C$$

• Investment banks will only operate a trading desk if  $\hat{\Pi}_B \ge 0$ 

Problem and assumptions	Independent traders	Fixed wages 000000	Performance wages 000●	Optimal remuneration	Summary 0000

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• Profits: 
$$\hat{\Pi}_B = E[\Pi] - \gamma w - C$$

- Investment banks will only operate a trading desk if  $\hat{\Pi}_B \ge 0$
- This requires  $\sigma_U \sigma_V \geq \frac{2C}{\gamma f} \sqrt{(1+\gamma f) \left(2 \left(1+f\right) (1+\gamma f)\right)}$

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Problem and assumptions	Independent traders	Fixed wages 000000	Performance wages	Optimal remuneration •000	Summary 0000

Problem and model assumptions

Independent traders

Fixed wages

Performance wages

Optimal trader remuneration

Summary

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	Problem and assumptions	Independent traders	Fixed wages 000000	Performance wages	Optimal remuneration	Summary 0000
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### Performance and fixed wages

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Problem and assumptions	Independent traders	Fixed wages 000000	Performance wages	Optimal remuneration	Summary 0000
Performance and	d fixed wages				

If a trading desk is operated, the bank needs to decide how to pay traders

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Problem and assumptions	Independent traders	Fixed wages 000000	Performance wages	Optimal remuneration	Summary 0000
Performance ar	nd fixed wages	5			

If a trading desk is operated, the bank needs to decide how to pay traders
 They will prefer paying a performance wage if Î<sub>B</sub> ≥ Π<sub>B</sub>

Problem and assumptions	Independent traders	Fixed wages 000000	Performance wages	Optimal remuneration	Summary 0000
Performance an	d fixed wage				

- If a trading desk is operated, the bank needs to decide how to pay traders
- ▶ They will prefer paying a performance wage if  $\hat{\Pi}_B \ge \Pi_B$
- This gives  $\sigma_U \sigma_V \ge \frac{C}{\frac{\gamma f}{2} \frac{1}{\sqrt{(1+\gamma f)(2(1+f)-(1+\gamma f))}} \frac{\gamma \frac{1}{2} \frac{2+f}{1+f}}{\sqrt{2\frac{1+\gamma f}{1+f} \left(\frac{1+\gamma f}{1+f}\right)^2 (1-\gamma)^2}}}$

Problem and assumptions	Independent traders	Fixed wages 000000	Performance wages	Optimal remuneration	Summary 0000
Performance an	d fixed wages	5			

- If a trading desk is operated, the bank needs to decide how to pay traders
- ▶ They will prefer paying a performance wage if  $\hat{\Pi}_B \ge \Pi_B$

- $\blacktriangleright$  This gives  $\sigma_U \sigma_V \geq - \frac{\frac{\gamma f}{2} \frac{1}{\sqrt{(1+\gamma f)(2(1+f)-(1+\gamma f))}} - \frac{\gamma - \frac{1}{2} \frac{2+f}{1+f}}{\sqrt{2\frac{1+\gamma f}{1+f} - \left(\frac{1+\gamma f}{1+f}\right)^2 - (1-\gamma)^2}}$
- If many informed traders are present, the costs of fixed wages are low

- If a trading desk is operated, the bank needs to decide how to pay traders
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- ▶ If the uncertainty is high, uninformed traders will make more losses

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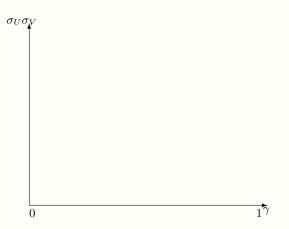
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	Problem and assumptions	Independent traders	Fixed wages 000000	Performance wages	Optimal remuneration	Summary 0000
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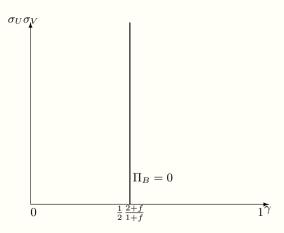
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Problem and assumptions	Independent traders	Fixed wages 000000	Performance wages	Optimal remuneration	Summary 0000



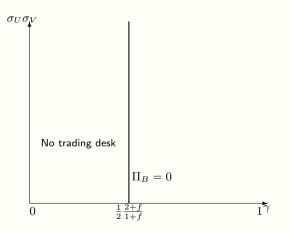
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Problem and assumptions	Independent traders	Fixed wages 000000	Performance wages 0000	Optimal remuneration	Summary 0000



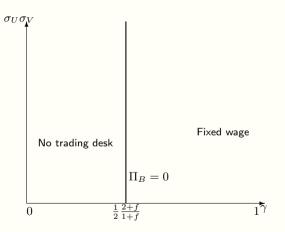
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Problem and assumptions	Independent traders	Fixed wages 000000	Performance wages 0000	Optimal remuneration	Summary 0000



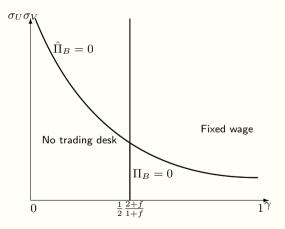
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Problem and assumptions	Independent traders 000	Fixed wages 000000	Performance wages 0000	Optimal remuneration	Summary 0000



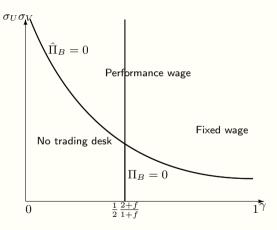
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Problem and assumptions	Independent traders	Fixed wages 000000	Performance wages	Optimal remuneration	Summary 0000

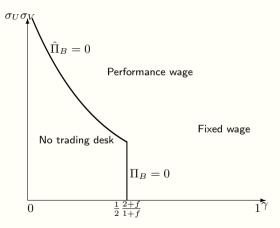


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Problem and assumptions	Independent traders 000	Fixed wages 000000	Performance wages 0000	Optimal remuneration	Summary 0000

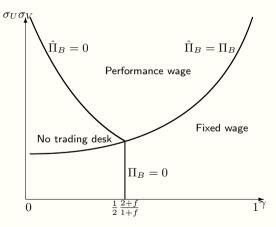


Problem and assumptions	Independent traders 000	Fixed wages 000000	Performance wages 0000	Optimal remuneration	Summary 0000

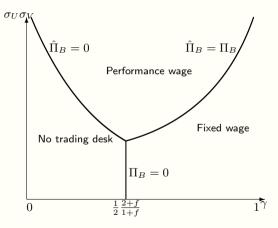


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Problem and assumptions	Independent traders	Fixed wages 000000	Performance wages	Optimal remuneration	Summary 0000

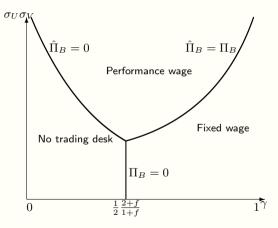


Problem and assumptions	Independent traders	Fixed wages 000000	Performance wages	Optimal remuneration	Summary 0000



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Problem and assumptions	Independent traders	Fixed wages 000000	Performance wages	Optimal remuneration	Summary 0000



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Problem and assumptions	Independent traders	Fixed wages 000000	Performance wages	Optimal remuneration	Summary 0000

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For few informed traders, the losses from employing uninformed traders are too high to allow a fixed wage

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- For many informed traders, the costs of paying uninformed traders is low compared to monitoring costs, making fixed wages more profitable

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Problem and assumptions	Independent traders	Fixed wages 000000	Performance wages	Optimal remuneration	Summary ●000

Problem and model assumptions

Independent traders

Fixed wages

Performance wages

Optimal trader remuneration

#### Summary

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Problem and assumptions	Independent traders	Fixed wages 000000	Performance wages	Optimal remuneration	Summary 0●00

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Investment banks will operate trading desks only if there is sufficient uncertainty in the market and they can employ enough informed traders

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- Markets with lower uncertainty and easily identified informed traders will see fixed wages being paid

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Problem and assumptions	Independent traders	Fixed wages 000000	Performance wages	Optimal remuneration	Summary 00●0

Problem and assumptions	Independent traders	Fixed wages 000000	Performance wages	Optimal remuneration	Summary 00●0

Trading in well-understood securities will be less attractive to investment banks

Problem and assumptions	Independent traders	Fixed wages 000000	Optimal remuneration	Summary 00●0

- ▶ Trading in well-understood securities will be less attractive to investment banks
- If traders can be identified as understanding a market sufficiently well, they will be paid performance wages

Problem and assumptions	Independent traders	Fixed wages 000000	Performance wages	Optimal remuneration	Summary 00●0

- Trading in well-understood securities will be less attractive to investment banks
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- This should be reflected in the importance of bonus payments in the total remuneration of traders

Problem and assumptions	Independent traders	Fixed wages 000000	Performance wages	Optimal remuneration	Summary 00●0

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