Providing Benefits to Uninformed Workers

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Motivation

1. **Importance of workplace benefits** $\nearrow$
   - Average US worker receives 31% of their total compensation in the form of pecuniary benefits, such as health insurance, paid leave, and retirement benefits (BLS 2022).
   - Benefits are more unequally distributed than wages (Kristal et al. 2020; Ouimet & Tate 2023; Pierce 2001).

2. **... but people are ill-equipped to evaluate complicated health insurance contracts and pension plans** (Beshears et al. 2018; Lusardi & Mitchell 2014).
   - For example: Poor knowledge of one's workplace pension plan is pervasive (Agnew et al. 2012, Gustman & Steinmeier 2005).
   - This improves with tenure (partly), possibly due to social interactions among colleagues (Duflo & Saez 2002, 2003).

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Q: What is the impact of workers' imperfect understanding of benefits, and subsequent learning, on compensation packages offered in equilibrium?

Paper in a Nutshell

Model:

- Multidimensional compensation packages with a *simple attribute* ("wage") and a *complex attribute* ("benefits").
  - Wages observable during search, benefits hidden (high/low).
- Two periods: Workers search à la McCall (1970). After accepting an offer, a worker learns the value of benefits on the job and can search again if unhappy.

Headline results:

1. With benefits unobservable prior to acceptance, an equilibrium with uniformly high benefits is more difficult to sustain than an equilibrium with uniformly low benefits, which ultimately harms firms' profits.
2. With two (belief-forming) worker types (informed vs. uninformed), there may exist additional equilibria with spurious differentiation in benefits.
   - "Perverse" & "fictitious compensating differentials" equilbiria.

Literature and Contribution

1. **Behavioural IO (Heidhues & Kőszegi 2018)**
   - Gamp & Krähmer (2022, 2023); Heidhues et al. (2021, 2023); Johnen (2019, 2020); Karle et al. (2023); Murooka & Schwarz (2019); Schumacher (2024)
2. **Behavioural Labour (Dohmen 2014)**
   - Bubb & Warren (2020); DellaVigna & Paserman (2005); Englmaier et al. (2023a,b); Jäger et al. (2024); Spinnewijn (2015)
3. **Provision of Workplace Benefits**
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   - Theoretical complement to empirical findings.

Search and Learning with Complex Attributes

Worker's (two-period) problem:

- At $t = 1$, the worker searches for a job at a cost $c_1 > 0$.
  - Random, sequential search with perfect recall (McCall 1970).
  - Having accepted an offer, the agent derives utility from being in employment and learns the value of the associated complex attribute.

- At $t = 2$, the worker decides whether to stay in current employment, or to search again at a cost $c_2 \geq c_1$.

- Total utility of worker i employed at firm k for a single period is:

$$u_{ik} \; = \; w_k + b_k$$

  where $b_k \in \{\underline{b}, \bar{b}\}$ for some $\bar{b} > \underline{b} > 0$.

- The worker maximises expected utility from being employed over two periods, net of search costs. Normalise $\underline{u} = 0$.

Worker's beliefs:

- Informed Workers:
  - The complex attribute b modelled as an experience good (Nelson 1970).
  - Beliefs about $b \,|\, w$ derived from the joint distribution of wages and benefits.
- Uninformed Workers:
  - Take into account the marginal distribution of benefits, but do not update beliefs about b given w, essentially displaying correlation neglect (Enke & Zimmermann 2019).
  - Consistent with: cursedness (Eyster & Rabin 2005); analogy-based reasoning (Jehiel 2005).
- Both types observe w perfectly and internalise future learning.

Workers' cutoff rules:

Lemma 1:

If $d\,\mathbb{E}[b\,|\,w]\,/\,d\,w \lesseqgtr 0$ for all w, then $R_2^U \gtreqless R_2^I$. If $d\,\mathbb{E}[b\,|\,w]\,/\,d\,w = 0$, then $R_2^U = R_2^I$.

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Lemma 2:

If $d\,\mathbb{E}[b\,|\,w]\,/\,d\,w \neq 0$ for some w, then the comparison between R_1^U and R_1^I is ambiguous. If $d\,\mathbb{E}[b\,|\,w]\,/\,d\,w = 0$ for all w, then $R_1^U = R_1^I$.

<u>Intuition:</u> Suppose negative correlation. Then:

1. Informed workers have a blunted incentive to search intensely,
2. but $R_2^I < R_2^U$ makes the initial choice more consequential!

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Intuition: Suppose negative correlation. Then:

1. Informed workers have a blunted incentive to search intensely,
2. but $R_2^I < R_2^U$ makes the initial choice more consequential!

$\Longrightarrow$ Any comparison between R_1^U and R_1^I hinges on a specific distribution of offers...

Equilibrium Analysis

Setup of the game:

- Unit mass of identical firms and workers.
- Firms simultaneously offer wage (w) and benefits (b), committing for two periods.
- Fraction $\lambda \in (0,1)$ of workers are uninformed, $(1-\lambda)$ are informed.

Firm's profit per worker per period:

$$\pi \ = \ y - w - (1-\tau)b$$

where y is output and $\tau > 0$ represents tax advantages.

$\rightarrow$ Offering $b = \bar{b}$ to all workers is efficient.

Look for (pure-strategy) *PBE with correlation neglect.* Definition

Proposition 1:

In any equilibrium with a degenerate distribution of benefits, the distribution of wage offers is also degenerate with $w^* = -b^*$.

1. An equilibrium in which all firms offer low benefits ($b^* = \underline{b}$) always exists.
2. An equilibrium in which all firms offer high benefits ($b^* = \bar{b}$) exists if both $c_2 \leq (\bar{b} - \underline{b})$ and $2\big(y + \tau\bar{b}\big) \geq y + \tau\underline{b} + (\bar{b} - \underline{b})$ hold.

Intuition: There is room for profitable deviation from $(w^*, \bar{b})$, but not $(w^*, \underline{b}) \implies$ Unobservability makes the high-benefits equilibrium more difficult to sustain. Derivation

- The above result doesn't depend on $\lambda \to$ Prop. 1 captures the effects of unobservability of benefits, rather than correlation neglect.
- Lower profits in low-benefits equilibrium $\to$ Information friction harms the firms.

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Evidence: Cole & Taska (2023), WP

- IV + survey experiment $\rightarrow$ Worker's WTP for workplace pension benefits is high.
- Calibrated model $\rightarrow$ **80% of firms provide suboptimally low benefits.**

Differentiated offers can co-exist in equilibrium if the informed and uninformed workers search differently ($R_1^I \neq R_1^U$).

- Firms posting the higher wage $w_H \equiv \max\{R_1^I, R_1^U\}$ hire all workers who contact them, while firms posting the lower wage $w_L \equiv \min\{R_1^I, R_1^U\}$ hire only one type.
- Since firms are identical, the two offers must yield equivalent expected profits.
  - Trade-off: profits per worker vs. the number of hires.

Distinguish between:

1. Fictitious compensating differentials equilibria, in which high-wage jobs provide low benefits ($b(w_H) = \underline{b}$) and low-wage jobs provide high benefits ($b(w_L) = \bar{b}$).
2. Perverse equilibria, in which high-wage jobs provide high benefits ($b(w_H) = \bar{b}$) and low-wage jobs provide low benefits ($b(w_L) = \underline{b}$).

Proposition 2:

A fictitious compensating differentials equilibrium, in which high wages are paired with low benefits, and vice versa, may exist. If the high-wage, low-benefits package is strictly more costly to provide, any such equilibrium requires the uninformed workers to search inefficiently hard for w_H in period 1. Conversely, if the high-wage, low-benefits package is weakly less costly to provide, any such equilibrium requires the uninformed workers to search inefficiently little for w_L in period 1. Differences in turnover are not necessary, but can feature in such equilibria.

In particular, the above does not rule out that jobs that are *more costly* to provide deliver *lower utility*. Derivation + examples

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Evidence: Lavetti (2023), JEP

- Information frictions make empirical estimates of comp. diff. difficult to interpret.

  "What factors might explain the skills bias puzzle? [...] If workers lack information about amenity levels at the time they make job choices, then equilibrium compensating wage differentials may reflect the subjective beliefs of the marginal worker rather than objective measures of amenities."

Proposition 3:

A perverse equilibrium, in which high wages are paired with high benefits, and vice versa, may exist. In any such equilibrium, uninformed workers accept all offers in period 1 and then leave low-wage, low-benefit jobs in period 2. Informed workers search for high-wage, high-benefit jobs in period 1 and remain employed in period 2.

A perverse equilibrium relies on strictly higher turnover of uninformed workers, in addition to them being the only type who accepts dominated offers. Derivation

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A perverse equilibrium relies on strictly higher turnover of uninformed workers, in addition to them being the only type who accepts dominated offers. Derivation

Evidence: Ouimet & Tate (2023), NBER WP

- Higher (instrumented) benefits predict lower turnover.

"Limited information can constrain the ability of new hires to value nonwage benefits prior to joining the firm, thus making wages relatively more salient when comparing multiple job offers."

Discussion - Behavioural Types

- On the equilibrium path, informed workers have correct beliefs about (w, b).
  - Unobservability of benefits prior to acceptance nonetheless determines the profitability of a deviation from high to low benefits.
- Uninformed workers appear to search by ignoring the benefits component.
  - Still, anticipation of future learning affects their search strategy.

Compared to the "shrouded prices equilibrium" in **Gabaix & Laibson (2006)**:

- Informed workers are equivalent to sophisticated consumers.
- Uninformed workers rank the offers as myopic consumers, but are less picky due to option value of future search, i.e. $R_1^U \leq R_1^{Myop}$ Derivation

$\Longrightarrow$ Modelling myopic consumers strengthens the case for equilibria in which uninformed search inefficiently hard, but weakens it for those in which they search inefficiently little.

Conclusion

This project analyses **the impact of workers' imperfect understanding of benefits, and subsequent learning, on compensation packages offered in equilibrium**.

1. With hidden benefits, firms have weak incentives to offer high benefits.
   - Inefficiently low benefits provision harms firms' profits.

2. Additionally, presence of *uninformed workers* can result in equilibria with spurious differentiation in benefits.
   - Neither *fictitious compensating differentials* nor *perverse equilibria* can be ruled out.
   - Model predictions match some "puzzling" empirical findings.

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To-Do: Study the interaction between information frictions and: screening / competition / productivity enhancements.

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Thanks very much for your attention!

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Appendix

Definition 1: *The workers' strategies summarised by* (R_1^j, R_2^j), $j \in \{I, U\}$, *the firms' strategies summarised by* (w_k, b_k), $k \in [0,1]$, *and workers' beliefs about the distribution of offers* (w, b) *constitute a (pure-strategy)* PBE with correlation neglect, *if:*

1. *The informed workers' beliefs about the joint distribution of wages and benefits are derived from the firms' strategies.*
2. *The uninformed workers' beliefs about the marginal distributions of wages and benefits are derived from the firms' strategies, but they display correlation neglect in that they perceive these two components as independently distributed.*
3. *Given their beliefs, informed and uninformed workers adopt perceived-optimal cutoff rules.*
4. *Given the strategies adopted by other players, each firm chooses its offer* (w_k, b_k) *to maximise its expected profit.*

Assumption 1: *Let* W^* *denote the set of wages offered in equilibrium. Upon observing a deviation to* $w_k \notin W^*$, *informed workers hold pessimistic beliefs about* b_k *and uninformed workers hold passive beliefs about* b_k. *Neither type updates their beliefs about the distribution of offers.*

Back

Derivation of Proposition 1:

Consider the case when all firms offer identical compensation: $w = w^*$, $b = b^*$.

- No role for correlation neglect $\rightarrow$ Both types hold correct beliefs.
- No role for learning $\rightarrow$ Workers expect to search exactly once and enter the labour market as long as:

$$2(w^* + b^*) - c_1 \geq 0$$

Conditional on b^*, all firms offer the same wage $w^* = R_1$, as in Diamond (1971):

$$w^* = \tfrac{c_1}{2} - b^*$$

Case 1: $b^* = \bar{b}$

- Deviation to $(w^*, \underline{b})$ is profitable if:
  1. A worker who accepted doesn't leave upon learning:
  $$c_2 \geq \bar{b} - \underline{b}$$
  2. or losing the worker doesn't hurt the firm:
  $$y - w^* - (1-\tau)\underline{b} > 2(y - w^* - (1-\tau)\bar{b})$$
- Deviation to $(\tilde{w}, \underline{b})$ for some $\tilde{w} > w^*$ which allows to retain a hired worker of either type turns out to be profitable if:
  $$c_2 > \tau(\bar{b} - \underline{b})$$

$\Longrightarrow$ High benefits offered in equilibrium if there's no profitable deviation.

Case 2: $b^* = \underline{b}$

- Any deviation would be strictly unprofitable.
  - With benefits unobservable prior to acceptance, deviating to $\bar{b}$ does not allow to lower the wage.

$\implies$ Low-benefits equilibrium always exists (provided that $\pi^* \geq 0$).

Proposition 1:

In any equilibrium with a degenerate distribution of benefits, the distribution of wage offers is also degenerate with $w^* = c_1/2 - b^*$.

1. An equilibrium in which all firms offer low benefits ($b^* = \underline{b}$) exists, provided that the firms make non-negative profits, i.e. $y + \tau\underline{b} \geq c_1/2$.
2. An equilibrium in which all firms offer high benefits ($b^* = \bar{b}$) exists if, in addition, $c_2 \leq \tau(\bar{b} - \underline{b})$ and $2\big(y - c_1/2 + \tau\bar{b}\big) \geq y - c_1/2 + (\bar{b} - \underline{b}) + \tau\underline{b}$ both hold.

Back

Derivation of Proposition 2:

- In a *fictitious compensating differentials equilibrium*, high-wage jobs provide low benefits ($b(w_H) = \underline{b}$), while low-wage jobs "compensate" by providing high benefits ($b(w_L) = \bar{b}$).

- Suppose that fraction $p \in (0, 1)$ of firms offer $(w_H, \underline{b})$.
  - Informed workers infer that the set of offers is $\{(w_H, \underline{b}); (w_L, \bar{b})\}$, while uninformed perceive it to be $\{(w_H, \underline{b}); (w_L, \bar{b}); (w_H, \bar{b}); (w_L, \underline{b})\}$.

- Then, the two types have the following value of searching on the job in period 2:

$$v_2^I = \max\{p(w_H + \underline{b}) + (1-p)(w_L + \bar{b}) - c_2\,;\ (w_H + \underline{b}) - c_2/p\,;\ (w_L + \bar{b}) - c_2/(1-p)\},$$
$$v_2^U = \max\{p(w_H + \underline{b}) + (1-p)(w_L + \bar{b}) - c_2\,;\ w_H + p\underline{b} + (1-p)\bar{b} - c_2/p\}.$$

- Restrict attention to $(w_H + \underline{b}) - c_2/p > (w_L + \bar{b}) - c_2/(1-p) \implies v_2^U \geq v_2^I$.

Case 1: $w_H + (1-\tau)\underline{b} > w_L + (1-\tau)\bar{b}$

- The high-wage, low-benefits package is more costly to provide.
- Does not rule out:

$$w_H + \underline{b} < w_L + \bar{b}$$

  Then, jobs that are *more costly* to provide also deliver *lower utility*.
  - Striking violation of the fundamental compensating differentials logic.
- To demonstrate that such equilibria do not rely on differences in turnover, I construct an equilibrium in which no worker searches on the equilibrium path.
  - High-wage jobs need to attract a larger mass of workers.
  - Requires that informed workers accept all offers, while uninformed search (inefficiently hard) for w_H.

- Expecting to remain in employment, an informed worker accepts the first offer sampled in period 1 if:

$$u_1^I(w_L) - u_1^I(w_H) \;=\; 2((\bar{b} - \underline{b}) - (w_H - w_L)) \;\leq\; c_1/(1-p)$$

- For $(w_L, \bar{b})$ to be offered in equilibrium, workers should search on the job upon discovering $(w_L, \underline{b})$. In this case, the relevant condition applies to the informed workers:

$$w_L + \underline{b} \;<\; p(w_H + \underline{b}) + (1-p)(w_L + \bar{b}) - c_2 \iff c_2 \;<\; p(w_H - w_L) + (1-p)(\bar{b} - \underline{b})$$

- Uninformed workers search for w_H in period 1 as long as:

$$u_1^U(w_H) - u_1^U(w_L) \;=\; (w_H - w_L) + p\big(\max\{(w_H + \underline{b})\,;\, v_2^U\} - v_2^U\big) + (1 - p)\big((w_H + \bar{b}) - \max\{(w_L + \bar{b})\,;\, v_2^U\}\big) \;>\; c_1/p$$

- What is v_2^U? Suppose that when searching on the job in period 2, uninformed workers also search for w_H:

$$(w_H - w_L) \; > \; c_2/p$$

$$\implies v_2^U = w_H + p\underline{b} + (1-p)\bar{b} - c_2/p$$

- Since $v_2^U > v_2^I$, both types stay employed in $(w_H, \underline{b})$ if:

$$w_H + \underline{b} \; \geq \; v_2^U \quad \iff \quad c_2/p \; \geq \; (1-p)(\bar{b} - \underline{b})$$

- But uninformed workers (plan to) leave $(w_L, \bar{b})$ when:

$$w_L + \bar{b} \; < \; v_2^U \quad \iff \quad c_2/p \; < \; (w_H - w_L) - p(\bar{b} - \underline{b}).$$

- Then, uninformed workers search for w_H in period 1 if:

$$u_1^U(w_H) - u_1^U(w_L) \;=\; (w_H - w_L) + p\big((w_H + \underline{b}) - w_H - p\underline{b} - (1-p)\bar{b} + c_2/p\big) + (1-p)\big((w_H + \bar{b}) - w_H - p\underline{b} - (1-p)\bar{b} + c_2/p\big) \;>\; c_1/p \iff$$

$$c_1/p \;<\; (w_H - w_L) + c_2/p$$

which is automatic.

Firms

- Firms' equal profits condition:

$$\pi(w_H) = 2((1-\lambda) + \tfrac{\lambda}{p})(y - w_H - (1-\tau)\underline{b}) = 2(1-\lambda)(y - w_L - (1-\tau)\bar{b}) = \pi(w_L) \iff$$

$$(1-\lambda)\,/\,((1-\lambda) + \tfrac{\lambda}{p}) \;=\; \frac{(y - w_H - (1-\tau)\underline{b})}{(y - w_L - (1-\tau)\bar{b})}$$

- Deviation from $(w_H, \underline{b})$ to $(w_H, \bar{b})$ is strictly unprofitable.
- Similarly, deviation to some $w \in (w_L, w_H)$ would attract only informed workers and is dominated by $(w_L, \bar{b})$.

- Finally, deviation from $(w_L, \bar{b})$ to $(w_L, \underline{b})$ is unprofitable as long as:

$$2(1-\lambda)(y - w_L - (1-\tau)\bar{b}) \;\geq\; (1-\lambda)(y - w_L - (1-\tau)\underline{b}) \iff$$
$$2 \;\geq\; \frac{(y-w_L-(1-\tau)\underline{b})}{(y-w_L-(1-\tau)\bar{b})}$$

Workers' PC

- To close the model, make the workers' PC's bind:

$$u_1^U(w_H) - c_1/p \;=\; 2(w_H + p\underline{b} + (1-p)\bar{b}) - c_1/p \;=\; 0$$

$$(1-p)u_1^I(w_L) + pu_1^I(w_H) - c_1 \;=\; 2((1-p)(w_L + \bar{b}) + p(w_H + \underline{b})) - c_1 \;=\; 0$$

Overall, such a fictitious compensating differentials equilibrium may exist as long as:

1. $c_1/(1-p) \ \geq \ 2((\bar{b}-\underline{b})-(w_H-w_L))$,
2. $c_2/p \ \geq \ (1-p)(\bar{b}-\underline{b})$,
3. $c_2/p \ < \ (w_H-w_L)-p(\bar{b}-\underline{b})$,
4. $(1-\lambda)\,/\,((1-\lambda)+\frac{\lambda}{p}) \ = \ \frac{(y-w_H-(1-\tau)\underline{b})}{(y-w_L-(1-\tau)\bar{b})}$,
5. $2 \ \geq \ \frac{(y-w_L-(1-\tau)\underline{b})}{(y-w_L-(1-\tau)\bar{b})}$,
6. $2(w_H+p\underline{b}+(1-p)\bar{b})-c_1/p \ = \ 0$,
7. $2((1-p)(w_L+\bar{b})+p(w_H+\underline{b}))-c_1 \ = \ 0$.

Numerical example:

For instance, as $p \to 1$, (i) and (ii) are trivially satisfied, while (vi) and (vii) coincide and solve for:

$$w_H = c_1/2 - \underline{b}$$

Then, (iv) implies:

$$w_L = \tfrac{-\lambda}{1-\lambda} y + \tfrac{1}{1-\lambda} c_1/2 - (1-\tau)\bar{b} - \tfrac{\tau}{1-\lambda}\underline{b}$$

The remaining conditions (iii) and (v) are satisfied for $\lambda = 0.50$, $y = 100$, $\underline{b} = 5.37$, $\bar{b} = 20.0$, $\tau = 0.11$, $c_1 = 4.30$, and $c_2 = 8.0$ (which imply $w_L = -114.67$ and $w_H = -3.20$), for example.

Case 2: $w_H + (1-\tau)\underline{b} \leq w_L + (1-\tau)\bar{b}$

- Implies:

$$w_L + \bar{b} \; > \; w_H + \underline{b}$$

$\rightarrow$ The "headline-attractive" option delivers lower total utility.

- Such an equilibrium relies on uninformed workers searching inefficiently little (for w_L). Can take the form of:

  a) Uninformed accept both w_L and w_H, while informed search for w_L in period 1.
  b) Both types accept all jobs in period 1, but uninformed search on the job upon discovering $(w_H, \underline{b})$.

$\rightarrow$ Here, I construct an equilibrium in which no type searches on the job, but low-wage, high-benefits jobs attract more workers.

- Requires that informed search for w_L in period 1, while uninformed accept both jobs.
- Then, uninformed workers get "stuck" in high-wage, low-benefit jobs.

- Informed workers search for $(w_L, \bar{b})$ in period 1 if:

$$u_1^I(w_L) - u_1^I(w_H) \;=\; 2((w_L + \bar{b}) - (w_H + \underline{b})) \;>\; c_1/(1-p)$$

- but would accept the first sampled offer in period 2 when:

$$(w_L + \bar{b}) - (w_H + \underline{b}) \;\leq\; c_2/(1-p)$$

$$\implies v_2^I = p(w_H + \underline{b}) + (1-p)(w_L + \bar{b}) - c_2.$$

- An informed worker therefore leaves $(w_L, \underline{b})$ if:

$$w_L + \underline{b} \;<\; p(w_H + \underline{b}) + (1-p)(w_L + \bar{b}) - c_2 \iff c_2 \;<\; p(w_H - w_L) + (1-p)(\bar{b} - \underline{b})$$

- but stays in $(w_H, \underline{b})$ if:

$$w_H + \underline{b} \;\geq\; p(w_H + \underline{b}) + (1-p)(w_L + \bar{b}) - c_2 \iff c_2 \;\geq\; (1-p)((w_L + \bar{b}) - (w_H + \underline{b}))$$

$\implies$ Of course, an informed worker never leaves $(w_L, \bar{b})$.

- When searching on the job, uninformed workers also accept the first offer if:

$$c_2/p \;\geq\; (w_H - w_L)$$

$\implies$ $v_2^U = v_2^I$ (same behaviour for any realisation in period 2).

- Then, uninformed workers accept the first offer sampled in period 1 if:

$$u_1^U(w_H) - u_1^U(w_L) \;=\; (w_H - w_L) + p\big((w_H + \underline{b}) - p(w_H + \underline{b}) - (1-p)(w_L + \bar{b}) + c_2\big) + (1-p)\big((w_H + \bar{b}) - (w_L + \bar{b})\big) \;=\; (2 - p^2)(w_H - w_L) - p(1-p)(\bar{b} - \underline{b}) + pc_2 \;\leq\; c_1/p$$

Firms

1. Equal profits on path:

$$\pi(w_H) \;=\; 2\lambda(y - w_H - (1-\tau)\underline{b}) \;=\; 2(\lambda + \tfrac{(1-\lambda)}{(1-p)})(y - w_L - (1-\tau)\bar{b}) \;=\; \pi(w_L) \iff$$

$$\lambda/(\lambda + \tfrac{(1-\lambda)}{(1-p)}) \;=\; \tfrac{(y-w_L-(1-\tau)\bar{b})}{(y-w_H-(1-\tau)\underline{b})}.$$

2. Deviation from $(w_L, \bar{b})$ to $(w_L, \underline{b})$ unprofitable:

$$2(\lambda + \tfrac{(1-\lambda)}{(1-p)})(y - w_L - (1-\tau)\bar{b}) \;\geq\; (\lambda + \tfrac{(1-\lambda)}{(1-p)})(y - w_L - (1-\tau)\underline{b}).$$

3. Deviation from $(w_H, \underline{b})$ to $(w_H, \bar{b})$ is never profitable.

4. Similarly, deviation to any $w \in (w_L, w_H)$ attracts only uninformed workers and is therefore dominated by $(w_L, \bar{b})$.

Workers' PC

- Binding PC of informed workers gives w_L:

$$u_1^I(w_L) - c_1/(1-p) \;=\; 2(w_L + \bar{b}) - c_1/(1-p) \;=\; 0$$

- While that of uninformed workers determines w_H:

$$pu_1^U(w_H) + (1-p)u_1^U(w_L) - c_1 \;=\; p\big(2(w_H + p\underline{b} + (1-p)\bar{b})\big) + (1-p)\big(w_L + p\underline{b} + (1-p)\bar{b} + (1-p)(w_L + \bar{b}) + p(p(w_H + \underline{b}) + (1-p)(w_L + \bar{b}) - c_2)\big) - c_1 \;=$$
$$p(2+p-p^2)w_H + (1-p)(2-p^2)w_L + (1-p)(2+p-p^2)\bar{b} + p(1+2p-p^2)\underline{b} - (1-p)pc_2 - c_1 \;=\; 0$$

In sum, the above equilibrium exists as long as the following hold simultaneously:

1. $c_1/(1-p) \; < \; 2((w_L+\bar{b})-(w_H+\underline{b}))$,
2. $c_2/(1-p) \; \geq \; (w_L+\bar{b})-(w_H+\underline{b})$,
3. $c_2 \; < \; p(w_H-w_L)+(1-p)(\bar{b}-\underline{b})$,
4. $c_2/p \; \geq \; (w_H-w_L)$,
5. $c_1/p \; \geq \; (2-p^2)(w_H-w_L)-p(1-p)(\bar{b}-\underline{b})+pc_2$,
6. $\lambda/(\lambda+\frac{(1-\lambda)}{(1-p)}) \; = \; \frac{(y-w_L-(1-\tau)\bar{b})}{(y-w_H-(1-\tau)\underline{b})}$,
7. $2(y-w_L-(1-\tau)\bar{b}) \; \geq \; (y-w_L-(1-\tau)\underline{b})$,
8. $u_1^I(w_L)-c_1/(1-p) \; = \; 2(w_L+\bar{b})-c_1/(1-p) \; = \; 0$,
9. $p(2+p-p^2)w_H+(1-p)(2-p^2)w_L+(1-p)(2+p-p^2)\bar{b}+p(1+2p-p^2)\underline{b}-(1-p)pc_2-c_1 \; = \; 0$.

Numerical example:

For instance, as $p \to 0$, (iv) and (v) are trivially satisfied, while (viii) and (ix) coincide and solve for:

$$w_L = c_1/2 - \bar{b}$$

Then, (vi) implies:

$$w_L = \frac{\lambda-1}{\lambda} y + \frac{1}{\lambda} c_1/2 - (1-\tau)\underline{b} - \frac{\tau}{\lambda}\bar{b}$$

The remaining conditions (i), (ii), (iii), and (vii) are satisfied for $\lambda = 0.80$, $y = 50$, $\underline{b} = 7.20$, $\bar{b} = 26.50$, $\tau = 0.134$, $c_1 = 12.35$, and $c_2 = 14.85$ (which imply $w_L = -20.325$ and $w_H = -15.45$), for example.

Back

Derivation of Proposition 3:

- In a *perverse equilibrium*, high-wage jobs provide high benefits ($b(w_H) = \bar{b}$), while low-wage jobs provide low benefits ($b(w_L) = \underline{b}$).

- Suppose that fraction $p \in (0, 1)$ of firms offer $(w_H, \bar{b})$.
  - Informed workers infer that the set of offers is $\{(w_H, \bar{b}); (w_L, \underline{b})\}$, while uninformed perceive it to be $\{(w_H, \bar{b}); (w_L, \underline{b}); (w_H, \underline{b}); (w_L, \bar{b})\}$.

- Then, the two types have the following values of searching in period 2:

$$v_2^I = \max\{p(w_H + \bar{b}) + (1-p)(w_L + \underline{b}) - c_2;\ w_H + \bar{b} - \frac{c_2}{p}\}$$

$$v_2^U = \max\{p(w_H + \bar{b}) + (1-p)(w_L + \underline{b}) - c_2;\ w_H + p\bar{b} + (1-p)\underline{b} - \frac{c_2}{p}\}$$

- Informed workers are more inclined to search on the job ($v_2^I \geq v_2^U$) and, if they do, to search for w_H.

- Since $c_2 \geq c_1$, no informed worker accepts an offer that induces them to search on the job (on the equilibrium path). However, uninformed workers may expect to search on the job for specific realisations of b and still accept.

- Since no worker leaves $(w_H, \bar{b})$, we have:

$$
\begin{aligned}
u_1^I(w_H) &= 2(w_H + \bar{b}), \qquad u_1^I(w_L) = 2(w_L + \underline{b}), \\
u_1^U(w_H) &= (w_H + p\bar{b} + (1-p)\underline{b} + p(w_H + \bar{b}) + (1-p)\max\{(w_H + \underline{b})\,;\, v_2^U\}, \\
u_1^U(w_L) &= (w_L + p\bar{b} + (1-p)\underline{b}) + p\max\{(w_L + \bar{b})\,;\, v_2^U\} + (1-p)\max\{(w_L + \underline{b})\,;\, v_2^U\}
\end{aligned}
$$

$$
\implies (u_1^I(w_H) - u_1^I(w_L)) > (u_1^U(w_H) - u_1^U(w_L))
$$

- If the two types search differently in period 1, it must be that informed workers search for $(w_H, \bar{b})$, while uninformed workers accept both w_L and w_H.

- It can be shown that for a perverse equilibrium to exist, the high-wage firms must attract AND retain more workers:

Lemma 3:
There do not exist perverse equilibria in which the differentiated offers induce the same turnover rate or attract the same mass of workers.

Therefore:

1. Only uninformed workers accept w_L.
2. Upon discovering $\underline{b}$ paired with w_L, all uninformed workers search on the job.

- Informed workers search for $(w_H, \bar{b})$ if:

$$u_1^I(w_H) - u_1^I(w_L) \;=\; 2((w_H - w_L) + (\bar{b} - \underline{b})) \;>\; c_1/p$$

- Uninformed workers accept both w_L and w_H if:

$$u_1^U(w_H) - u_1^U(w_L) = (w_H - w_L) + p\left((w_H + \bar{b}) - \max\{w_L + \bar{b}, v_2^U\}\right) + (1-p)\left(\max\{w_H + \underline{b}, v_2^U\} - \max\{w_L + \underline{b}, v_2^U\}\right) \leq \frac{c_1}{p}$$

- Uninformed worker leaves $(w_L, \underline{b})$ if:

$$w_L + \underline{b} \; < \; v_2^U \; = \; p(w_H + \bar{b}) + (1-p)(w_L + \underline{b}) - c_2 \quad \Longleftrightarrow$$

$$c_2 \; < \; p\big((w_H - w_L) + (\bar{b} - \underline{b})\big)$$

since $c_2 \geq c_1$.

- What about the remaining (off-path) realisations?

- Uninformed worker leaves $(w_H, \underline{b})$ if:

$$c_2 \; < \; -(1-p)(w_H - w_L) + p(\bar{b} - \underline{b})$$

  (This also implies $v_2^I > w_H + \underline{b}$.)

- Uninformed worker stays in $(w_L, \bar{b})$ if:

$$c_2 \; \geq \; p(w_H - w_L) - (1-p)(\bar{b} - \underline{b})$$

  (Otherwise, accepting w_L in period 1 cannot be optimal.)

- Then:

$$u_1^U(w_H) - u_1^U(w_L) \; = \; (1+p)(w_H - w_L) \; \leq \; c_1/p$$

Firms

1. Equal profits on path:

$$\pi(w_H) \;=\; (2\,\frac{1-\lambda}{p} + 2\lambda + \lambda(1-p)) \times (y - w_H - (1-\tau)\bar{b}) \;=$$
$$\pi(w_L) \;=\; (\lambda + \lambda(1-p)) \times (y - w_L - (1-\tau)\underline{b})$$

2. Deviation from $(w_H, \bar{b})$ to $(w_H, \underline{b})$ unprofitable:

$$(2\,\tfrac{1-\lambda}{p} + 2\lambda + \lambda(1-p)) \times (y - w_H - (1-\tau)\bar{b}) \;\geq$$
$$(\tfrac{1-\lambda}{p} + \lambda + \lambda(1-p)) \times (y - w_H - (1-\tau)\underline{b})$$

3. Deviation from $(w_L, \underline{b})$ to $(w_L, \bar{b})$ unprofitable:

$$(\lambda + \lambda(1-p)) \times (y - w_L - (1-\tau)\underline{b}) \;\geq\; (2\lambda + \lambda(1-p)) \times (y - w_L - (1-\tau)\bar{b})$$

Workers' PC

- Given their off-path beliefs, the condition for uninformed workers to accept w_L in period 1 becomes:

$$(1+p)(w_H - w_L) \;\leq\; c_1/p$$

- Then, the uninformed worker's PC is binding when:

$$\begin{aligned} pu_1^U(w_H) + (1-p)u_1^U(w_L) - c_1 \;&=\\ 2pw_H + 2(1-p)w_L + p(3-p)\bar{b} + (1-p)(2-p)\underline{b} - c_1 - (1-p)c_2 \;&=\; 0 \end{aligned}$$

- The PC of an informed worker who searches for w_H in period 1 is binding when:

$$u_1^U(w_H) - c_1/p \;=\; 2(w_H + \bar{b}) - c_1/p \;=\; 0$$

Overall, for such an equilibrium to exist, the following must hold simultaneously:

1. $c_1/p \ < \ 2((w_H - w_L) + (\bar{b} - \underline{b}))$,
2. $c_1/p \ \geq \ (1+p)(w_H - w_L)$,
3. $(2\,\frac{1-\lambda}{p} + (3-p)\lambda)/((2-p)\lambda) \ = \ \frac{(y - w_L - (1-\tau)\underline{b})}{(y - w_H - (1-\tau)\bar{b})}$,
4. $c_2 \ < \ p(\bar{b} - \underline{b}) - (1-p)(w_H - w_L)$,
5. $(2\,\frac{1-\lambda}{p} + (3-p)\lambda)/(\frac{1-\lambda}{p} + (2-p)\lambda) \ \geq \ \frac{(y - w_H - (1-\tau)\underline{b})}{(y - w_H - (1-\tau)\bar{b})}$,
6. $c_2 \ \geq \ p(w_H - w_L) - (1-p)(\bar{b} - \underline{b})$,
7. $(3-p)/(2-p) \ \leq \ \frac{(y - w_L - (1-\tau)\underline{b})}{(y - w_L - (1-\tau)\bar{b})}$,
8. $2pw_H + 2(1-p)w_L + p(3-p)\bar{b} + (1-p)(2-p)\underline{b} - c_1 - (1-p)c_2 \ = \ 0$,
9. $2(w_H + \bar{b}) - c_1/p \ = \ 0$.

Back

In the case of differentiated offers:

$$\begin{aligned} u_1^U(w_H) - u_1^U(w_L) &= (w_H - w_L) + q\Big(\underbrace{(w_H + \bar{b}) - \max\{(w_L + \bar{b})\,;\, v_2^U\}}_{\leq (w_H - w_L)}\Big) \\ &\quad + (1-q)\Big(\underbrace{\max\{(w_H + \underline{b})\,;\, v_2^U\} - \max\{(w_L + \underline{b})\,;\, v_2^U\}}_{\leq (w_H - w_L)}\Big) \\ &\leq 2(w_H - w_L) = u_1^{Myop}(w_H) - u_1^{Myop}(w_L) \end{aligned}$$

where $q \in \{p, 1-p\}$.

Back