# Taxation, Redistribution and Frictional Labor Supply


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# Taxing with Frictions

- Worker's pay depends on output produced and share of output kept.
- Low pay because of *low talent* or because matched with an *extractive firm*.
- Opportunity to search and match with a firm that extracts less and pays more creates **job ladders**.
- *How should policy be designed in face of ex ante dispersion in worker talent and ex post risk of moving up, falling off or getting stuck on the job ladder?*

# Taxing with Frictions

- **Part 1**: General Framework for Thinking about Taxes in Frictional Environments.
- **Part 2**: Structural Frictional Model: Mirrlees (1971) + Burdett and Mortensen (1998).

  1. Private variation in worker talent.
  2. Intensive effort margin.
  3. Job creation and matching.
  4. On and off the job search.
  5. Taxes and benefits.

# Taxing with Frictions: Job Price Squeeze

- Higher taxes $\Rightarrow$ most extractive firms must pay more to attract workers from unemployment.
- Competition for workers causes higher paying firms to raise worker incomes too. Revenues per job (“job price") squeezed.
- The job price squeeze:
  1. Raises incomes and income tax revenues.
  2. Reduces profit tax revenues.
  3. Redistributes within and across talent markets.
  4. Deters job creation.

☞ *Taxes have complicated general equilibrium implications for job creation and the distribution of job prices that policymakers must consider.*

# Taxing with Frictions: Preview

- Theory: New optimal tax formulas.
  - Show how labor market frictions modify existing formulas.
- Quantitative: Model calibrated to the U.S. economy.
  - Frictions imply lower optimal marginal taxes.

# Related Literature

- **Taxing with Exogenous Wages:** Mirrlees (1971); Diamond (1998), Saez (2001).
- **Taxation with Endogenous Wages:** Stiglitz (1982); Rothschild-Scheuer (2013, 2014); Ales-Kurnaz-Sleet (2015), Ales-Bellofatto-Wang (2014); Scheuer-Werning (2015,2016); Ales-Sleet (2016), Sachs-Tsyvinski-Werquin (2016), Stantcheva (2014).
- **Taxing with Search Frictions:** Boone-Bovenberg (2002, 2006); Hungerbühler et al (2006); Lehmann et al (2012), Golosov-Maziero-Menzio (2013); Bagger et al (2017).
- **Search Frictions:** Burdett-Mortensen (1998); Shimer (2012); Hornstein-Krusell-Violante (2011).

# Taxing with Frictions

# Policy

- **Policy**: $p = (b, T)$ is a benefit $b \in \mathbb{R}_+$ and an income tax function $T : \mathbb{R}_+ \to \mathbb{R}$.
  - Affine Tax: $T[x] = T_0 + \tau x$.
  - Nonlinear Tax: $T[x]$ is smooth.

# Worker Characteristics

**Workers:** Distributed over:

- **Talent** $\theta \in [\underline{\theta}, \overline{\theta})$.
  - Talent $\theta$ exerting effort $e$ produces $z = \theta e$.
  - Distributed according to $K$.
- **Job opportunities.**
  - option to work.
  - fraction with an opportunity: $\mu(\theta; p)$.
- **Job prices** $q \in \mathbb{R}_+$.
  - Output captured by employer.

    Worker residual claimant. Earnings: $x = \theta e - q$.
  - Distribution of workers over job prices: $\omega[q|\theta; p]$.

    ☞ Inverse $q(\omega, \theta; p)$.

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# Worker Characteristics

**Workers:** Distributed over: **Frictionless**

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  - option to work.
  - fraction with an opportunity: $\mu(\theta; p)$. — $\mu(\theta; p) = 1$.
- **Job prices** $q \in \mathbb{R}_+$.
  - Output captured by employer.

    Worker residual claimant. Earnings: $x = \theta e - q$.
  - Distribution of workers over job prices: $\omega[q|\theta; p]$. — $\omega[0|\theta; p] = 1$.

    ☞ Inverse $q(\omega, \theta; p)$. — $q(\omega, \theta; p) = 0$.

# Worker Preferences and Choices

- Like consumption, dislike effort:

$$U : \mathbb{R}_+ \times [0, \bar{e}) \to \mathbb{R}.$$

- Without job opportunity:

$$U(b, 0).$$

- With job opportunity:

$$\Phi(q, \theta; p) = \max_{I} (1 - I) U(b, 0) + I \max_{x \in \mathbb{R}_+} U\left(x - T[x], \frac{x + q}{\theta}\right).$$

  - Choose whether to work $I$ and earnings $x$.

# Policymaker's Problem

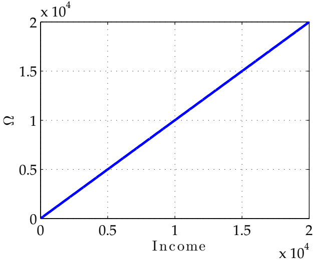
- Utiliarian policymaker maximizes expected payoff subject to budget constraint:

$$\max_p E[U] + \Lambda \cdot \{E[T] + \Pi - b \cdot u - \mathcal{G}\}$$

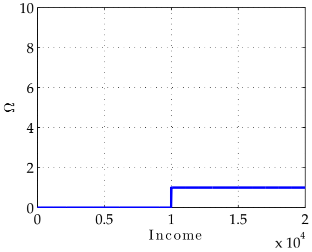
  - $E[T]$ expected income tax revenues; $\Pi$ profit tax revenues.
  - $u$ unemployment rate, i.e. fraction without or who decline job opportunities.
  - $\mathcal{G}$ government spending.

▸ Full Statement

# Perturbations




(a) Affine $\Omega(x) = x$.




(b) Limiting Nonlinear $\mathbb{I}_{\$10,000}$.

- Optimal values denoted with $^*$.
- Tax perturbation: $T^* + \varepsilon\Omega$.
  - ☞ Affine: $\Omega(x) = x$.
  - ☞ Nonlinear: $\Omega(x) = \mathbb{I}_{x_0}(x)$; $\Omega'(x) = \mathbb{D}_{x_0}(x)$.
- Marginal impact of perturbation:
  - $\partial f^*(\Omega) = \frac{d}{d\varepsilon} f(T^* + \varepsilon\Omega)\big|_{\varepsilon=0}$.

# Optimal Perturbation: Frictionless

$$\underbrace{E\left[\frac{U_c^*}{\Lambda^*}\mathcal{H}^*(\Omega)\right]}_{\text{Tax Payer welfare loss}}$$

$$= \underbrace{E[\Omega(x^*)]}_{\text{Mechanical Revenue Gain}} + \underbrace{E\left[T^{*\prime}[x^*]\partial x^*(\Omega)\right]}_{\text{Behavioral/Equilibrium Revenue Loss from Workers}}$$

$$+ \underbrace{E\left[(T^* - b^*)\partial(1-u^*)(\Omega)\right]}_{\text{Unemployment Revenue Loss}}$$

Where:

- $\mathcal{H}^*(\Omega) = \mathbb{I}_e \Omega(x^*)$

  Income loss (net of effort change) = Extra Tax paid.

- $$\partial x^*(\Omega) = -\frac{x^*}{1-T'[x^*]}\frac{\mathcal{E}^{c*}}{1+\frac{T''[x^*]x^*}{1-T'[x^*]}\mathcal{E}^{c*}}\Omega'(x^*) - \frac{1}{1-T'^*[x^*]}\frac{\eta^*}{1+\frac{T''^*[x^*]x^*}{1-T'^*[x^*]}\mathcal{E}^{c*}}\Omega(x^*)$$

  Pre-tax income response.

- $\partial(1-u^*)(\Omega) = -\mathbb{D}_{\tilde{\theta}^*} \cdot \partial\tilde{\theta}^*(\Omega)$

  Employment response.

# Optimal Perturbation: Frictional

$$\underbrace{E\left[\frac{U_c^*}{\Lambda^*}\mathcal{H}^*(\Omega)\right]}_{\substack{\text{Tax Payer}\\ \text{welfare loss}}} + \underbrace{E\left[\frac{U^* - U(b^*,0)}{\Lambda^*}(-\partial\mu^*)(\Omega)\right]}_{\substack{\text{Invol unemployment}\\ \text{welfare loss}}}$$

$$= \underbrace{E[\Omega(x^*)]}_{\substack{\text{Mechanical}\\ \text{Revenue Gain}}} + \underbrace{E\left[T^{*\prime}[x^*]\partial x^*(\Omega)\right]}_{\substack{\text{Behavioral/Equilibrium}\\ \text{Revenue Loss from Workers}}}$$

**New Terms!**

$$+ \underbrace{E\left[(T^* - b^*)\partial(1-u^*)(\Omega)\right]}_{\substack{\text{Unemployment}\\ \text{Revenue Loss}}} + \underbrace{\partial\Pi^*(\Omega)}_{\text{Proft Tax Loss}}$$

# Optimal Perturbation

$$\underbrace{E\left[\frac{U_c^*}{\Lambda^*}\mathcal{H}^*(\Omega)\right]}_{\substack{\text{Tax Payer} \\ \text{welfare loss}}} + \underbrace{E\left[\frac{U^* - U(b^*,0)}{\Lambda^*}(-\partial\mu^*)(\Omega)\right]}_{\substack{\text{Invol unemployment} \\ \text{welfare loss}}}$$

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$$+ \underbrace{E\left[(T^* - b^*)\partial(1-u^*)(\Omega)\right]}_{\substack{\text{Unemployment} \\ \text{Revenue Loss}}} + \underbrace{\partial\Pi^*(\Omega)}_{\text{Proft Tax Loss}}$$

Where:

$$\mathcal{H}^*(\Omega) = \mathbb{I}_e\{\Omega(x^*) + (1 - T^{*\prime}[x^*])\partial q^*(\Omega)\}$$

- $\partial q^*(\Omega) =$ impact of tax on job price paid by worker.
- $\partial q^*(\Omega) < 0 \Rightarrow$ tax incidence falls on job prices.
- Then, cost to tax payers mitigated.
- Social benefit enhanced if low incomes have larger job price falls.

# Optimal Perturbation

$$\underbrace{E\left[\frac{U_c^*}{\Lambda^*}\mathcal{H}^*(\Omega)\right]}_{\text{Tax Payer welfare loss}} + \underbrace{E\left[\frac{U^* - U(b^*,0)}{\Lambda^*}(-\partial\mu^*)(\Omega)\right]}_{\text{Invol unemployment welfare loss}}$$

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$$+ \underbrace{E\left[(T^* - b^*)\partial(1-u^*)(\Omega)\right]}_{\text{Unemployment Revenue Loss}} + \underbrace{\partial\Pi^*(\Omega)}_{\text{Proft Tax Loss}}$$

Where:

$$\partial x^*(\Omega) = -\frac{x^*}{1-T'[x^*]}\frac{\mathcal{E}^{c*}}{1+\frac{T''[x^*]x^*}{1-T'[x^*]}\mathcal{E}^{c*}}\Omega'(x^*)$$
$$-\frac{1}{1-T'^*[x^*]}\frac{\eta^*}{1+\frac{T''^*[x^*]x^*}{1-T'^*[x^*]}\mathcal{E}^{c*}}\Omega(x^*)$$
$$+\frac{1-\eta^*}{1+\frac{T''^*[x^*]x^*}{1-T'^*[x^*]}\mathcal{E}^{c*}}(-\partial q^*(\Omega)).$$

- Incidence of taxes on job prices raises incomes and so income tax tax revenues paid by workers.

# Optimal Perturbation

$$E\left[\frac{U_c^*}{\Lambda^*}\mathcal{H}^*(\Omega)\right] + E\left[\frac{U^* - U(b^*, 0)}{\Lambda^*}(-\partial\mu^*)(\Omega)\right]$$

(Tax Payer welfare loss; Invol unemployment welfare loss)

$$= E[\Omega(x^*)] + E\left[T^{*\prime}[x^*]\partial x^*(\Omega)\right]$$

(Mechanical Revenue Gain; Behavioral/Equilibrium Revenue Loss from Workers)

$$+ E\left[(T^* - b^*)\partial(1 - u^*)(\Omega)\right] + \partial\Pi^*(\Omega)$$

(Unemployment Revenue Loss; Proft Tax Loss)

But:

$$E\left[\frac{U^* - U(b^*, 0)}{\Lambda^*}(-\partial\mu^*)(\Omega)\right]$$

- Utility losses for job losers.

$$E\left[\frac{T^* - b^*}{1 - u^*}\partial(1 - u^*)(\Omega)\right]$$

- Revenue losses from job losers. Includes change in job opportunities and job acceptances.

# Optimal Perturbation

$$\underbrace{E\left[\frac{U_c^*}{\Lambda^*}\mathcal{H}^*(\Omega)\right]}_{\text{Tax Payer welfare loss}} + \underbrace{E\left[\frac{U^* - U(b^*,0)}{\Lambda^*}(-\partial\mu^*)(\Omega)\right]}_{\text{Invol unemployment welfare loss}}$$

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And:

$$\partial\Pi^*(\Omega)$$

- If job prices accrue as firm profits and these are taxed at 100%. Tax incidence on job prices depresses profit taxes.

# Structural Search and Tax Model

- Time continuous.
- Attention restricted to steady state equilibria and time invariant policy.
- Workers and firms trade effort for income in frictional labor markets segmented by talent.
- Preferences, technologies as before. Matching technology and firm behavior now spelt out.
- Job opportunity fraction $\mu$ and job prices $q$ explicitly derived as functions of policy.

# A foot on the ladder

- **Jumping onto the Ladder**:

  1. Unemployed $\theta$ worker meets firm at rate $\lambda(\theta;p)$;
  2. conditional on meeting draw job price $q$;
  3. accepts, derives flow utility $\Phi(q,\theta;p) = \max_x U\left(x - T[x], \frac{x+q}{\theta}\right)$ if $q \leq \overline{q}(\theta;p)$, where:

$$\Phi(\overline{q}(\theta;p),\theta;p) = \max_x \; U\left(x - T[x], \frac{x + \overline{q}(\theta;p)}{\theta}\right) = U(b,0).$$

☞ $\overline{q}(\theta;p)$ is **maximum** job price that will be accepted in market $\theta$.

☞ $\overline{q}(\theta;p)$ is decreasing in $T[\underline{x}(\theta;p)]$, $\underline{x}(\theta;p) = \arg\max_x \; U\left(x - T[x], \frac{x+\overline{q}(\theta;p)}{\theta}\right)$

# Climbing the ladder. And falling off.

- **Climbing Ladder**:

  1. Employed $\theta$ worker with job price $q$ meets new firm at rate $\lambda(\theta; p)$;
  2. conditional on meeting, draws job price $q'$;
  3. accepts and moves if $q' < q$;
  4. if accepts and moves, gets $\Phi(q', \theta; p)$ and earn $x(q', \theta; p)$.

☞ Moving **up** ladder means moving to **lower** job price, **higher** income.

- **And Falling Off**:
  - Employed workers' jobs destroyed at rate $\delta$.
  - Workers enter unemployment pool after job loss.

# Firms

- Firms choose vacancies $v$, job prices $q$ in each talent market to maximize steady state flow profit:

$$\max_{v,q} \quad \underbrace{R(q;\theta,p)}_{\substack{\text{Expected}\\\text{revenues}\\\text{per vacancy}}} \cdot v - \underbrace{\kappa(v;\theta)}_{\text{Vacancy cost}} .$$

- Firms tradeoff being small & extractive (large $q$) vs. large & generous (small $q$).

- In equilibrium, firms distribute themselves over a set of $q$'s over which they are indifferent.

- Firms do not enter talent markets $[\underline{\theta}, \tilde{\theta}(p)]$, where:

$$\overline{q}(\tilde{\theta}(p), p) = 0.$$

# Matching

- $v(\theta; p) =$ vacancies created in talent market $\theta$ by firms.
- Standard matching technology:

$$m(v(\theta; p), k(\theta); p) = \chi v(\theta; p)^{\alpha} k(\theta)^{1-\alpha}.$$

- Equilibrium matching rates for workers:

$$\lambda(\theta; p) := \chi \left( \frac{v(\theta; p)}{k(\theta)} \right)^{\alpha}.$$

- $\delta =$ rate at which jobs are destroyed.
- $\frac{\lambda}{\delta}$ extent of frictions. Frictionless limit: $\frac{\lambda}{\delta} \to \infty$

# Steady state equilibria

- $\mu(\theta;p) = 1 - u(\theta;p) = \frac{\lambda(\theta;p)}{\delta+\lambda(\theta;p)}$.

- Job opportunity fraction.

- $\omega[q|\theta;p] = \frac{\delta+\lambda(\theta;p)}{\lambda(\theta)} - \frac{\delta}{\lambda(\theta;p)}\sqrt{\frac{\overline{q}(\theta;p)}{q}}$

- Steady state distribution of workers over job prices.

$$\Rightarrow \quad q(\omega;\theta,p) = \left(\frac{1}{1+\frac{\lambda(\theta;p)}{\delta}(1-\omega)}\right)^2 \overline{q}(\theta;p)$$

- Invert to get job price function.

- $\kappa(\theta) = \frac{\chi^{\frac{1}{\alpha}}\delta\overline{q}(\theta;p)}{(\delta+\lambda(\theta;p))^2}\lambda(\theta;p)^{\frac{\alpha-1}{\alpha}}$.

- Firm first order condition; linear vacancy cost.

*Key: policy impacts job opportunity fractions and job price functions via its impact on maximal job prices*, $\overline{q}$.

# Job Price Implications

$$\partial \overline{q}(\Omega)(\theta;p) = -\frac{\Omega(\underline{x}(\theta;p))}{1-T'[\underline{x}(\theta;p)]} < 0$$

- Higher taxes squeeze maximal job prices.
  - Unemployment outside option sets floor.
  - $\overline{q}$ must fall to compensate workers for higher taxes.
  - Squeeze depends on $\Omega(\underline{x}(\theta;p))$ and $T'$.

$$\frac{\partial q(\Omega)(\omega,\theta;p)}{q(\omega,\theta;p)} = -\mathcal{R}(\omega,\theta;p)\frac{\Omega(\underline{x}(\theta;p))}{1-T'[\underline{x}(\theta;p)]} < 0$$

- And job prices fall along job ladder.
  - Competition transmits fall in $\overline{q}$ up job ladder.
  - Weakens as we move up ladder (to lower $q$ and $\omega$).
  - Dampened too by disincentive to post vacancies.

# Job Price Implications

$$\frac{\partial q(\Omega)(\omega,\theta;p)}{q(\omega,\theta;p)} = -\mathcal{R}(\omega,\theta;p)\frac{\Omega(\underline{x}(\theta;p))}{1-T'[\underline{x}(\theta;p)]} < 0$$

- Tax incidence falls on job prices.
  - Especially at bottom of job ladders, reinforces redistributive goals.
  - But pattern of incidence across talent markets (may) overturn this.
  - Affine tax perturbations or nonlinear tax perturbations at high incomes depress high talent job prices and benefit high earners.

$$\frac{\partial \mu(\Omega)(\theta;p)}{\mu(\theta;p)} = -\left(1-\mu(\theta;p)\right)\frac{\mathcal{L}(\theta;p)}{\overline{q}(\theta;p)}\frac{\Omega(\underline{x}(\theta;p))}{1-T'[\underline{x}(\theta;p)]} < 0$$

- Higher taxes diminish fraction of workers with job.

- Profit taxes also diminished.

# Calibration

# Simple Burdett-Mortensen model with exogenous match rate

- Exogenous matching rate: $\lambda(\theta; p) = \chi$; firms cannot scale arrival rate of meetings by posting multiple vacancies.

- **Matching**, $\alpha = 0$,

$$m(v, k(\theta); p) = \chi k(\theta), \qquad \Rightarrow \lambda(\theta; p) = \chi.$$

- **Vacancy cost**:

$$\kappa(v, \theta) = \begin{cases} 0 & v \in [0, 1] \\ \infty & v > 1 \end{cases} \qquad \Rightarrow \Pi(p) = E[q|p].$$

# Calibration

- **Worker preferences**

$$U(c-h(y)) = \frac{1}{1-\sigma}\left(c - \frac{1}{1+\gamma}y^{1+\gamma}\right)^{1-\sigma}.$$

  - Baseline: $\sigma = 2$, $\gamma = 1$, $\gamma = 2$.

- **Labor market**

  - $\delta = 0.03$. (Monthly, Shimer (2012)).
  - $\lambda = 0.118$.
    - $\lambda_u = 0.4$ (Monthly, Shimer (2012)), $\lambda_e = 0.12$. (Hornstein-Krusell-Violante (2011)).
    - $\lambda = 0.06 \times \lambda_u + 0.94 \times \lambda_e \approx 0.118$.

# Recovering talent distribution

$$h(x;p) = \int_{\underline{\theta}(x;p)}^{\overline{\theta}(x;p)} P(x|\theta;p)k(\theta)d\theta \qquad \textbf{(*)}$$

- $h =$ density of employed across current incomes. From data.

where:

$$P(x|\theta;p) = \frac{\delta}{2\lambda}\sqrt{\frac{\frac{T_0-b}{1-\tau} + \frac{\gamma}{1+\gamma}\theta^{\frac{1+\gamma}{\gamma}}(1-\tau)^{\frac{1}{\gamma}}}{\{(1-\tau)^{\frac{1}{\gamma}}\theta^{\frac{1+\gamma}{\gamma}} - x\}^3}}$$

for $\theta \in [\underline{\theta}(x;p), \overline{\theta}(x;p)]$

- $P$ is kernel giving conditional distribution of talents over income. Given by model.

- Would like to invert (*).
- Fredholm equation of first kind: Utilize analogy with estimation of random coefficients models.

# Recovering talent distribution

- Fix income grid, basis functions $\{\zeta_r\}$ for $k$.
- Compute discrete income distribution implied by each basis function, e.g.

$$\ell_{i,r} = \int_{x_i}^{x_{i+1}} \int_{\underline{\theta}(x;p)}^{\overline{\theta}(x;p)} P(x|\theta;p)\zeta_r(\theta)d\theta dx$$

- Estimate basis function weights $a$ to best matches empirical income distribution, e.g.

$$a = \arg\min_{a \in \Delta^R} \sum_{i=1}^{I} \left( \hat{H}_i - \sum_{r=1}^{R} a_r \ell_{i,r} \right)^2, \quad \hat{H}_i = \text{fraction of workers in data with } x \in [x_i, x_{i+1}]$$

- Approximate $\hat{k} = \sum_{r=1}^{R} a_r \zeta_r$.

▸ Calibrating the general model

# Calibration: Talent Distribution

- Empirical earnings distb'n from CPS March 2016 release.
- Affine approximation to current US government tax policy:

$$T[x] = \underset{(2.526)}{-302.56} + \underset{(0.000361)}{0.336}\, x.$$

# Calibrated Talent Densities

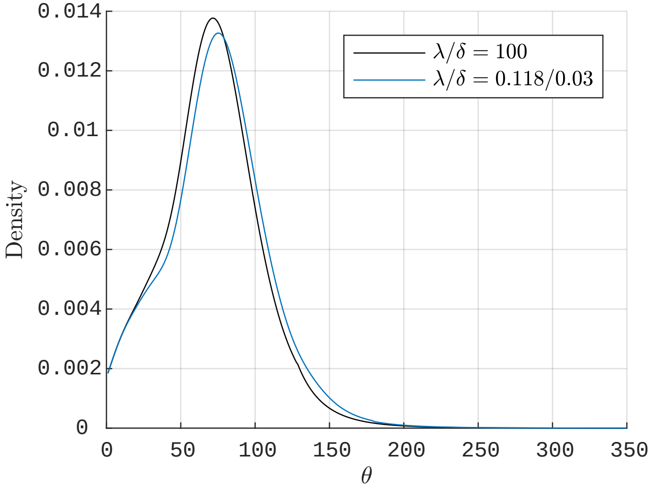


Figure: Talent densities

# Results: Optimal Affine Taxation

# Optimal Affine Tax Perturbation

Recall Affine Tax: $T^*[x] = T_0 + \tau^* x$,

First order condition is:

$$\underbrace{-\text{Cov}\left[\frac{U_c^*}{E[U_c^*]}, \mathcal{H}^*\right]}_{\substack{\text{Redistribution} \\ \text{Benefit}}} = \underbrace{\frac{\tau^*}{1-\tau^*} E[x^* \mathcal{E}^{c*}]}_{\substack{\text{Behavioral/Equilibrium} \\ \text{Revenue Loss}}} + \underbrace{\frac{\lambda^*}{\lambda^* + \delta}(b^* - T[x^*(\tilde{\theta}^*)])\frac{\tilde{\theta}^* \mathcal{E}^*_{\tilde{\theta}}}{1-\tau^*} k(\tilde{\theta}^*)}_{\substack{\text{Revenue Loss} \\ \text{Extensive Margin}}}$$

Where:

$$\mathcal{H}^* = \underbrace{x^* + (1-\tau^*)\partial q^*}_{\substack{\text{Tax induced job price adjustment} \\ \text{dampens redistribution from high earners}}}$$

# Optimal Affine Policy

| **Variable** | $\mathcal{G} = 0.25,\ \gamma = 1$ | | |
|---|---|---|---|
| | $\frac{\lambda}{\delta} \approx 4$ | $\frac{\lambda}{\delta} = 10$ | $\frac{\lambda}{\delta} = 100$ |
| $\tau$ | 30.4 | 32.8 | 35.0 |
| $T_0$ | 162 | 259 | 334 |
| $b$ | 749 | 727 | 699 |
| $\pi$ | 263 | 128 | 15 |
| PS | $-4.7 \times 10^{-4}$ | $-1.7 \times 10^{-4}$ | $-7.7 \times 10^{-6}$ |

$T_0$, $b$, $\pi$: *monthly 2015 US \$ amounts.* $\pi =$ *per capita monthly profit. PS = sum of Profit Squeeze terms in tax equation.*

- Frictions: a force for moderately lower taxes.
- Squeezing of profit tax revenues and redistribution across talent markets trumps redistribution within talent markets.

▸ Sensitivity

# Results: Optimal Nonlinear Taxation

# Optimal Nonlinear Tax Perturbation

Optimal tax function locally linear $\Rightarrow$

$$\underbrace{-\text{Cov}\left[\frac{U_c^*}{E[U_c^*]}, \mathcal{H}^*\right]}_{\substack{\text{Redistribution}\\\text{Benefit}}} = \underbrace{\frac{T^{*\prime}[x_0]x_0}{1-T^{*\prime}[x_0]} E[\mathcal{E}^{c*}|x_0]h^*(x_0)}_{\substack{\text{Behavioral/Equilibrium}\\\text{Revenue Loss}}}$$

Where:

$$\mathcal{H}^* = \underbrace{\mathbb{I}_e\{\mathbb{I}_{x_0}(x^*)+(1-T^{*\prime}[x^*])\partial q^*(\mathbb{I}_{x_0})\}}_{\substack{\text{Tax induced job price adjustment}\\\text{dampens redistribution from high earners}}}$$

▸ Full Formula

# Optimal Tax Rates

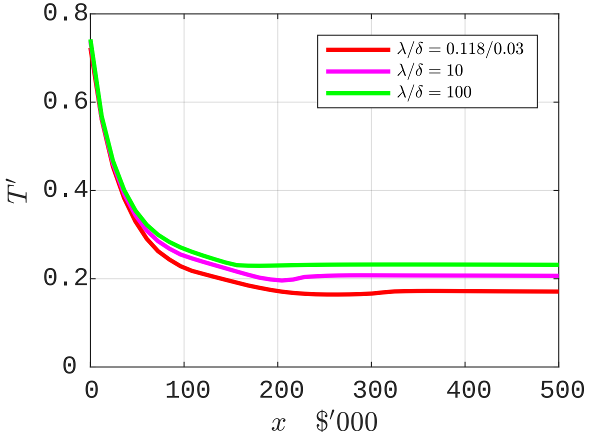


Figure: Marginal tax rates as function of income $x$ when $\gamma = 1$. Plotted for the baseline value of $\lambda/\delta = 4$ and $\lambda/\delta = 10, 100$. Also, $\mathcal{G} = 0.25\times$ GDP.

▸ Sensitivity

# Conclusions

- In (frictional) labor markets, incomes depend on talent and extractiveness of employer.
- Workers distributed across employers adopting different job pricing strategies and unemployment.
- Taxes have complicated general equilibrium implications for job creation and the distribution of job prices:
  - Higher $T$ squeezes job prices and raises worker incomes.
  - Raises income tax revenues, but lowers profit tax revenues.
  - Redistributes within and across talent markets.
  - Deters vacancy creation and lowers employment.
- Quantitative analysis suggests accounting for frictions leads to lower income tax prescriptions.

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# Social Payoff and Budget Constraint

- Expected payoff to the population of workers is:

$$U(b,0)\left\{\int_\theta \{1-\mu(\theta;p)\}K(d\theta)+\left\{\int_q \{1-I(q,\theta;p)\}G[dq|\theta;p]\right\}\mu(\theta;p)K[d\theta]\right\}$$
$$+\int_\theta\int_q I(q,\theta;p)\Phi(q,\theta;p)G[dq|\theta;p]\mu(\theta;p)K[d\theta].$$

- Budget constraint:

$$-b\int_\Theta\left\{\{1-\mu(\theta;p)\}+\int_{\mathbb{R}_+}\{1-I(q,\theta;p)\}G[dq|\theta;p]\mu(\theta;p)\right\}K[d\theta]$$
$$+\int_\Theta\int_{\mathbb{R}_+} I(q,\theta;p)T[x(q,\theta;p)]G[dq|\theta;p]\mu(\theta;p)K[d\theta]+\Pi(p),$$

where $\Pi(p)$ is profit tax revenue.

Go Back

# Policy problem

- Lagrangian:

$$\max_p U(b,0)\left\{\int_\theta \{1-\mu(\theta;p)\}K(d\theta) + \left\{\int_q \{1-I(q,\theta;p)\}G[dq|\theta;p]\right\}\mu(\theta;p)K[d\theta]\right\}$$
$$+\int_\theta\int_q I(q,\theta;p)\Phi(q,\theta;p)G[dq|\theta;p]\mu(\theta;p)K[d\theta]$$
$$+\Lambda\left\{-b\int_\Theta\left\{\{1-\mu(\theta;p)\}+\int_{\mathbb{R}_+}\{1-I(q,\theta;p)\}G[dq|\theta;p]\mu(\theta;p)\right\}K[d\theta]\right.$$
$$\left.+\int_\Theta\int_{\mathbb{R}_+} I(q,\theta;p)T[x(q,\theta;p)]G[dq|\theta;p]\mu(\theta;p)K[d\theta]+\Pi(p)\right\}$$

- Perturbations at optimum:
  - $\partial f^*(\Omega) = \frac{d}{d\varepsilon} f(T^* + \varepsilon\Omega)\Big|_{\varepsilon=0}$, for $\Omega =$ perturbation function;
    - ☞ Affine case: $\Omega(x) = x$ or $\Omega(x) = 1$.
    - ☞ Nonlinear case: $\Omega(x) = \mathbb{I}_{x_0}(x)$; $\Omega'(x) = \mathbb{D}_{x_0}(x)$.

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# Optimal perturbation: Frictionless

$$\underbrace{E\left[\frac{U_c^*}{\Lambda^*}\mathcal{H}^*(\Omega)\right]}_{\text{Tax Payer welfare loss}} + \underbrace{E\left[\frac{U^* - U(b^*,0)}{\Lambda^*}\mathcal{K}^*(\Omega)\right]}_{\text{Invol unemployment welfare loss}}$$

$$= \underbrace{E[\Omega(x^*)]}_{\text{Mechanical Revenue Gain}} + \underbrace{E\left[T^{*\prime}[x^*]\partial x^*(\Omega)\right]}_{\text{Behavioral/Equilibrium Revenue Loss from Workers}}$$

$$+ \underbrace{E\left[\frac{T^* - b^*}{1-u^*}\partial(1-u^*)(\Omega)\right]}_{\text{Unemployment Revenue Loss}} + \underbrace{\partial\Pi^*(\Omega)}_{\text{Proft Tax Loss}}$$

Where:

$$\mathcal{H}^*(\Omega) = \mathbb{I}_e\{\Omega(x^*) + (1 - T^{*\prime}[x^*])\partial q^*(\Omega)\}$$

$$\partial x^*(\Omega) = -\frac{x^*}{1-T'[x^*]}\frac{\mathcal{E}^{c*}}{1+\frac{T''[x^*]x^*}{1-T'[x^*]}\mathcal{E}^{c*}}\Omega'(x^*)$$

$$-\frac{1}{1-T'^*[x^*]}\frac{\eta^*}{1+\frac{T''^*[x^*]x^*}{1-T'^*[x^*]}\mathcal{E}^{c*}}\Omega(x^*)$$

$$+\frac{1+\eta^*}{1+\frac{T''^*[x^*]x^*}{1-T'^*[x^*]}\mathcal{E}^{c*}}\partial q^*(\Omega)$$

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# Recovering talent distribution and vacancy cost

- Step 1: Obtain estimates of talent density conditional on employment $\phi$ and unemployment $\nu$, unconditional talent density $k$ and match rate $\lambda$.
  - Fix income grid, basis functions $\{\zeta_r\}$ for $\phi$, $\{\xi_r\}$ and $\nu$ and initial $\lambda^0$.
  - Given $\lambda^j$, compute discrete income distribution implied by each basis function, e.g.

$$\ell_{i,r}^j = \int_{x_i}^{x_{i+1}} \int_{\underline{\theta}(x;p,\lambda^j)}^{\overline{\theta}(x;p)} P(x|\theta;p,\lambda^j)\zeta_r(\theta)d\theta dx$$

  - Estimate basis function weights $a^j$ and $b^j$ to best matches distributions in data, e.g.

$$a^j = \arg\min_{a\in\Delta^R} \sum_{i=1}^{I} \left(\hat{H}_i - \sum_{r=1}^{R} a_r \ell_{i,r}^j\right)^2, \quad \hat{H}_i = \text{fraction of workers in data with } x \in [x_i, x_{i+1}]$$

  - Use approximations $\hat{\phi}^j = \sum_{r=1}^R a_r^j \zeta_r(\theta)$ and $\hat{\nu}^j = \sum_{r=1}^R b_r \xi_r^j(\theta)$ and definitions to build estimates of $\hat{k}$ and $\hat{\lambda}$.
  - Repeat steps with $j = j + 1$ if $\|\lambda^{j+1} - \lambda^j|\| > \varepsilon$.
- Step 2: Use firm first order conditions to recover vacancy cost function $\kappa$.

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# Optimal Affine Policy under Lower LS Elasticity

| **Variable** | $\mathcal{G} = 0.25,\ \gamma = 2$ | | |
|---|---|---|---|
| | $\frac{\lambda}{\delta} \approx 4$ | $\frac{\lambda}{\delta} = 10$ | $\frac{\lambda}{\delta} = 100$ |
| $\tau$ | 44.8 | 47.3 | 48.4 |
| $L$ | 714 | 812 | 827 |
| $b$ | 1102 | 1054 | 1003 |
| $\pi$ | 346 | 174 | 20 |

*Notes:* $L$, $b$ *and* $\pi$ *are monthly 2015 US \$ amounts.* $\pi$ *is per capita monthly profit.*

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# Optimal Tax Rates under Lower LS Elasticity

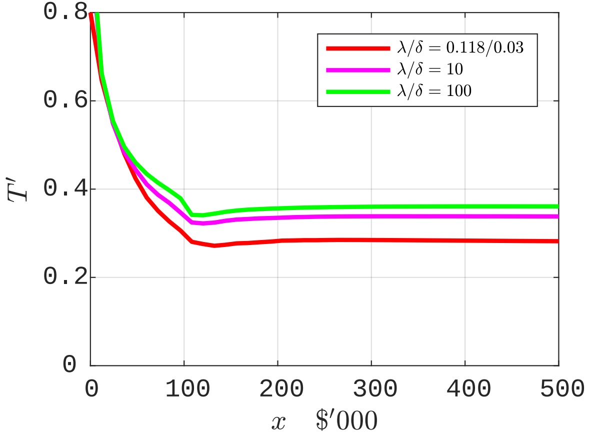


Figure: Marginal tax rates as function of income $x$ when $\gamma = 2$. Plotted for the baseline value of $\lambda/\delta = 4$ and $\lambda/\delta = 10, 100$. Also, $\mathcal{G} = 0.25\times$ GDP.

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# Optimal Nonlinear Tax Perturbation

$$\underbrace{-\text{Cov}\left[\frac{U_c^*}{E[U_c^*]}, \mathcal{H}^*\right]}_{\substack{\text{Redistribution}\\ \text{Benefit}}}$$

$$= \underbrace{E\left[T^{*\prime}[x^*]\{-\partial x^*\}\right]}_{\substack{\text{Behavioral/Equilibrium}\\ \text{Revenue Loss from Workers}}}$$

$$\underbrace{+\, E[T^{*\prime}[x^*]\{-\partial q^*]\}}_{\text{Net Proft Tax Loss}}$$

Where:

$$\mathcal{H}^* = \mathbb{I}_e\{\mathbb{I}_{x_0}(x^*) + (1 - T^{*\prime}[x^*])\partial q^*\}$$

$$-\partial x^* = \frac{x^*}{1 - T'[x^*]} \frac{\mathcal{E}^{c*}}{1 + \frac{T''[x^*]x^*}{1 - T'[x^*]}\mathcal{E}^{c*}} \mathbb{D}_{x_0}(x^*) + \frac{1}{1 + \frac{T''^*[x^*]x^*}{1 - T'^*[x^*]}\mathcal{E}^{c*}} \partial q^*$$

$$\frac{\partial q^*(\omega, \theta)}{q^*(\omega, \theta)} = -\mathcal{R}^*(\omega, \theta) \frac{\mathbb{I}_{x_0}(\underline{x}^*(\theta))}{1 - T^{*\prime}[\underline{x}^*(\theta)]}$$