Taxation, Redistribution and Frictional Labor Supply

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Becker-Friedman Institute
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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.


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 ⇒ 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.

\[\text{Taxes have complicated general equilibrium implications for job creation and the distribution of job prices that policymakers must consider.}\]
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).


• **Search Frictions**: Burdett-Mortensen (1998); Shimer (2012); Hornstein-Krusell-Violante (2011).
Taxing with Frictions
**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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\[\text{\small \textsuperscript{9} / \textsuperscript{38}}\]
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    Inverse $q(\omega, \theta; p)$.

- Frictionless

  $\mu(\theta; p) = 1$.

  $\omega[0|\theta; p] = 1$.

  $q(\omega, \theta; p) = 0$. 
Worker Preferences and Choices

• Like consumption, dislike effort:

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

• 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

• Utilitarian policymaker maximizes expected payoff subject to budget constraint:

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

• \(E[T]\) expected income tax revenues; \(\Pi\) profit tax revenues.

• \(u\) unemployment rate, i.e. fraction without or who decline job opportunities.

• \(G\) government spending.
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:** $\Omega(x) = \mathbb{I}_{x_0}(x)$; $\Omega'(x) = I_{x_0}(x)$.

- Marginal impact of perturbation:
  
  - $\partial f^*(\Omega) = \left. \frac{d}{d\varepsilon} f(T^* + \varepsilon \Omega) \right|_{\varepsilon=0}$. 

Optimal Perturbation: Frictionless

\[
E \left[ \frac{U^*_c}{\Lambda^*} \mathcal{H}^*(\Omega) \right]
\]

Tax Payer welfare loss

\[
= E[\Omega(x^*)] + E \left[ T^{*'}[x^*] \partial x^*(\Omega) \right] + E \left[ (T^* - b^*) \partial(1 - u^*)(\Omega) \right]
\]

Mechanical Revenue Gain

\]

Behavioral/Equilibrium Revenue Loss from Workers

\]

Unemployment Revenue Loss

Where:

- \( \mathcal{H}^*(\Omega) = \Pi_e \Omega(x^*) \)

Income loss (net of effort change)

= Extra Tax paid.

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

Pre-tax income response.

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

Employment response.
Optimal Perturbation: Frictional

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

- Tax Payer welfare loss
- Involuntary unemployment welfare loss

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

- Mechanical Revenue Gain
- Behavioral/Equilibrium Revenue Loss from Workers

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

- Unemployment Revenue Loss
- Profit Tax Loss
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**

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

Where:

- \( \partial q^*(\Omega) = \) 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.

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

- **Mechanical Revenue Gain**

- **Behavioral/Equilibrium Revenue Loss from Workers**

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

- **Unemployment Revenue Loss**

- **Profit Tax Loss**
Optimal Perturbation

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

- Tax Payer welfare loss

\[ = E[\Omega(x^*)] + E \left[ T^{*'}[x^*] \partial x^*(\Omega) \right] + E \left[ (T^* - b^*) \partial (1 - u^*)(\Omega) \right] + \partial \Pi^*(\Omega) \]

- Mechanical Revenue Gain

- Invol unemployment welfare loss

- Behavioral/Equilibrium Revenue Loss from Workers

- Unemployment Revenue Loss

- Profit Tax Loss

Where:

\[ \partial x^*(\Omega) = - \frac{x^*}{1 - T'[x^*]} - \frac{1}{1 - T''[x^*]} \left( 1 + \frac{\eta^*}{\partial \mu^*} \right) \]

\[ - \frac{\mathcal{E}_c^*}{1 - T''[x^*]} \frac{\Omega'(x^*)}{\mathcal{E}_c^*} \]

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

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

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

Tax Payer welfare loss

Invol unemployment welfare loss

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

Mechanical Revenue Gain

Behavioral/Equilibrium Revenue Loss from Workers

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

Unemployment Revenue Loss

Profit 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

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

Tax Payer welfare loss

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= E[\Omega(x^*)] + E \left[ T^*[x^*] \partial x^*(\Omega) \right]
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Mechanical Revenue Gain

Invol unemployment welfare loss

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

Behavioral/Equilibrium Revenue Loss from Workers

Unemployment Revenue Loss

Prof Tax Loss

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.
• **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 \( T[x(\theta; p)], x(\theta; p) = \arg \max_x U \left( x - T[x], \frac{x + \overline{q}(\theta; p)}{\theta} \right) \)
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:

\[
\max_{v,q} \left( R(q; \theta, p) \cdot v - \kappa(v; \theta) \right).
\]

- Expected revenues per vacancy
- 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 \([\theta, \tilde{\theta}(p)]\), 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: \( \frac{\lambda}{\delta} \rightarrow \infty \)
Steady state equilibria

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

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

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

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

• Job opportunity fraction.

• Steady state distribution of workers over job prices.

• Invert to get job price function.

• Firm first order condition; linear vacancy cost.

**Key:** policy impacts job opportunity fractions and job price functions via its impact on maximal job prices, \( \bar{q}. \)
Job Price Implications

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

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

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

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

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

- 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.

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

- Higher taxes diminish fraction of workers with job.
- Profit taxes also diminished.

• Tax incidence falls on job prices.
• Especially at bottom of job ladders, reinforces redistributive goals.
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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,** \( \alpha = 0 \),

\[
m(v, k(\theta); p) = \chi k(\theta), \quad \Rightarrow \lambda(\theta; p) = \chi.
\]

- **Vacancy cost:**

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

\[ h(x; p) = \int_{\theta(x; p)}^{\bar{\theta}(x; p)} P(x|\theta; p) k(\theta) d\theta \quad (*) \]

where:

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

for \( \theta \in [\theta(x; p), \bar{\theta}(x; p)] \)

- \( h \) = density of employed across current incomes. From data.

- \( P \) 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.

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

- 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 \( \hat{k} = \sum_{r=1}^{R} a_r \zeta_r \).
Calibration: Talent Distribution

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

\[ T[x] = -302.56 + 0.336 \times x. \]
Calibrated Talent Densities

Figure: Talent densities
RESULTS: OPTIMAL AFFINE TAXATION
Recall Affine Tax: \( T^*[x] = T_0 + \tau^*x \),

First order condition is:

\[
-Cov \left[ \frac{U_c^*}{E[U_c^*]}, H^* \right] = \frac{\tau^*}{1 - \tau^*} E[x^* E^c]\]

\[
\text{Redistribution Benefit} \quad \text{Behavioral/Equilibrium} \quad \text{Revenue Loss}
\]

\[
\frac{\lambda^*}{\lambda^* + \delta} (b^* - T[x^*(\tilde{\theta}^*)]) \frac{\tilde{\theta}^* E^*}{1 - \tau^*} k(\tilde{\theta}^*) \]

\[
\text{Revenue Loss} \quad \text{Extensive Margin}
\]

Where:

\[
H^* = x^* + (1 - \tau^*) \partial q^*
\]

\[
\text{Tax induced job price adjustment} \quad \text{dampens redistribution from high earners}
\]
### Optimal Affine Policy

<table>
<thead>
<tr>
<th>Variable</th>
<th>$G = 0.25, \gamma = 1$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\frac{\lambda}{\delta} \approx 4$</td>
</tr>
<tr>
<td>$\tau$</td>
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</tr>
<tr>
<td>$T_0$</td>
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<tr>
<td>$b$</td>
<td>749</td>
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<tr>
<td>$\pi$</td>
<td>263</td>
</tr>
<tr>
<td>PS</td>
<td>$-4.7 \times 10^{-4}$</td>
</tr>
</tbody>
</table>

$T_0, b, \pi$: 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.
RESULTS: OPTIMAL NONLINEAR TAXATION
Optimal Nonlinear Tax Perturbation

Optimal tax function locally linear ⇒

\[ -\text{Cov} \left[ \frac{U_c^*}{E[U_c^*]}, \mathcal{H}^* \right] = \frac{T^*[x_0]x_0}{1 - T^*[x_0]} E[\mathcal{E}^{c*}|x_0]h^*(x_0) \]

Redistribution Benefit

Behavioral/Equilibrium Revenue Loss

Where:

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

Tax induced job price adjustment dampens redistribution from high earners

Full Formula

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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, $G = 0.25 \times$ GDP.
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.
Taxation, Redistribution and Frictional Labor Supply

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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.
Policy problem

• Lagrangian:

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

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

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

• Perturbations at optimum:

• \( \partial f^*(\Omega) = \frac{d}{d\varepsilon} f(T^* + \varepsilon\Omega) \bigg|_{\varepsilon=0} \), for \( \Omega = \text{perturbation function} \);

   • Affine case: \( \Omega(x) = x \) or \( \Omega(x) = 1 \).

   • Nonlinear case: \( \Omega(x) = \mathbb{I}_{x_0}(x) \); \( \Omega'(x) = \mathbb{D}_{x_0}(x) \).
Optimal perturbation: Frictionless

\[
E \left[ \frac{U^*_c}{\Lambda^*} \mathcal{H}^*(\Omega) \right] + E \left[ \frac{U^*}{\Lambda^*} \mathcal{H}^*(\Omega) \right]
\]

- Tax Payer welfare loss
- Involuntary unemployment welfare loss

\[
= E[\Omega(x^*)] + E \left[ T^*[x^*] \partial x^*(\Omega) \right]
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- Mechanical Revenue Gain
- Behavioral/Equilibrium Revenue Loss from Workers

\[
+ E \left[ \frac{T^*[x^*]}{1-T^*[x^*]} \partial x^*(\Omega) \right] + \mathcal{W}^*(\Omega)
\]

- Unemployment Revenue Loss
- Profit Tax Loss

Where:

\[
\mathcal{H}^*(\Omega) = \mathbb{I}_e \{ \Omega(x^*) \} \mathcal{W}^*(\Omega) \mathcal{W}^*(\Omega)
\]

\[
\partial x^*(\Omega) = - \frac{x^*}{1 - T'[x^*]} \left( \frac{\mathcal{E}_c^*}{1 - T'[x^*]} \right) \Omega'(x^*)
\]

\[
- \frac{1}{1 - T'[x^*]} \left( \frac{\eta^*}{1 - T'[x^*]} \right) \mathcal{E}_c^* \Omega(x^*)
\]

\[
\mathcal{W}^*(\Omega) = \frac{1}{1 - T'[x^*]} \mathcal{C}_c^* \Omega(x^*)
\]
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.
    \[
    \ell^j_{i,r} = \int_{x_i}^{x_{i+1}} \int_{\theta(x;p)} \bar{\theta}(x;p) \ P(x|\theta;p,\lambda^j) \zeta_r(\theta) d\theta dx
    \]

  • Estimate basis function weights $a^j$ and $b^j$ to best matches distributions in data, e.g.
    \[
    a^j = \arg \min_{a \in \Delta^R} \sum_{i=1}^{I} \left( \hat{H}_i - \sum_{r=1}^{R} a_r \ell^j_{i,r} \right)^2, \quad \hat{H}_i = \text{fraction of workers in data with } x \in [x_i, x_{i+1}]
    \]

  • Use approximations $\hat{\phi}^j = \sum_{r=1}^{R} a_r \zeta_r(\theta)$ and $\hat{\nu}^j = \sum_{r=1}^{R} b_r \xi_r(\theta)$ 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 $\kappa$. 
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.
    \[
    \ell^j_{i,r} = \int_{x_i}^{x_{i+1}} \int_{\tilde{\theta}(x;p)} P(x|\theta;p,\lambda^j)\zeta_r(\theta)d\theta dx
    \]
  - Estimate basis function weights $a^j$ and $b^j$ to best matches distributions in data, e.g.
    \[
    a^j = \arg \min_{a \in \Delta R} \sum_{i=1}^{L} \left( \hat{H}_i - \sum_{r=1}^{R} a_r \ell^j_{i,r} \right)^2, \quad \hat{H}_i = \text{fraction of workers in data with } x \in [x_i, x_{i+1}]
    \]
  - Use approximations $\hat{\phi}^j = \sum_{r=1}^{R} a^j_r \zeta_r(\theta)$ and $\hat{\nu}^j = \sum_{r=1}^{R} b^j_r \xi^j_r(\theta)$ 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 $\kappa$. 

- Go Back
**Optimal Affine Policy under Lower LS Elasticity**

<table>
<thead>
<tr>
<th>Variable</th>
<th>( G = 0.25, \gamma = 2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \frac{\lambda}{\delta} \approx 4 )</td>
<td>( \frac{\lambda}{\delta} = 10 )</td>
</tr>
<tr>
<td>( \tau )</td>
<td>44.8</td>
</tr>
<tr>
<td>( L )</td>
<td>714</td>
</tr>
<tr>
<td>( b )</td>
<td>1102</td>
</tr>
<tr>
<td>( \pi )</td>
<td>346</td>
</tr>
</tbody>
</table>

*Notes:* \( L, b \) and \( \pi \) are monthly 2015 US $ amounts. \( \pi \) is per capita monthly profit.
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, $G = 0.25 \times$ GDP.
Optimal Nonlinear Tax Perturbation

\[-\text{Cov} \left[ \frac{U_c^*}{E[U_c^*]}, \mathcal{H}^* \right] \]

Redistribution Benefit

\[
= E \left[ T^*[x^*] \{ -\partial x^* \} \right]
\]

Behavioral/Equilibrium Revenue Loss from Workers

\[
+ E[T^*[x^*]\{ -\partial q^* \}]
\]

Net Profit Tax Loss

Where:

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

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

\[
+ \frac{1}{1 + \frac{T''[x^*]x^*}{1 - T'[x^*]} \mathcal{E}_c^*} \partial q^*
\]

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