Equilibrium Worker-Firm Allocations and the Deadweight Losses of Taxation

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Motivation

- Labor income is taxed and workers' and firms' behavioral responses involve fiscal externalities
- Studies of optimal taxation (e.g. Mirrlees, 1971) focus on worker effort with exogenous gross compensation
- The tax system may, however, also influence the allocation of workers to firms, and hence gross wages and profits
- Labor markets are frictional and characterized by
  - Two-sided heterogeneity, wage dispersion
  - Worker and job flows persistent and pervasive

  and matching is integral to value creation in labor markets
- We study deadweight losses of taxation in a labor market w/ frictions where taxation has allocative implications

Contribution I

- On-the-job search model w/ amenities to study how matching is distorted and deadweight losses arise when income is taxed
- Identify hitherto overlooked deadweight losses from taxation obtained via distorted
  - Job search effort
  - Ranking of jobs
  - Vacancy creation
- New deadweight losses are *in addition* to conventional deadweight losses from the intensive margin of labor supply (not shown today)
- Characterize the optimal linear tax function for a planner with redistributive preferences

Contribution II (somewhat preliminary)

- Calibrate the model to data from Denmark: Deadweight losses from distorted matching are economically important
  - Elasticity of taxable income (ETI) is -0.11
- Decompose the marginal deadweight losses
  - Distorted job search effort: 40 percent
  - Distorted job ranking: 3 percent
  - Distorted vacancy creation: 57 percent
- Quantitative optimal linear income tax analysis (hard to rationalize the Danish average 64.3% tax rate)

Methodology

- Competitive search equilibrium *maximizes* workers' after-tax-and-transfer utility, and is constrained efficient in laissez-faire
  - *Clarity*: Apportion dead-weight losses to frictions *per se*, not congestion or inefficient contracting
  - *Tractability*: Closed form expressions for the dead-weight losses
  - *Drawback:* Consider linear (affine) tax functions only
- Quantitative policy analysis based on calibrated model deviate from the "sufficient statistics approach" popular in public economics. Why?
  - Labor market adjustments potentially takes long to materialize
  - Tax reforms do not create treatment/control groups
  - ETI only captures current dead-weight loss and not dead-weight losses for different tax systems.

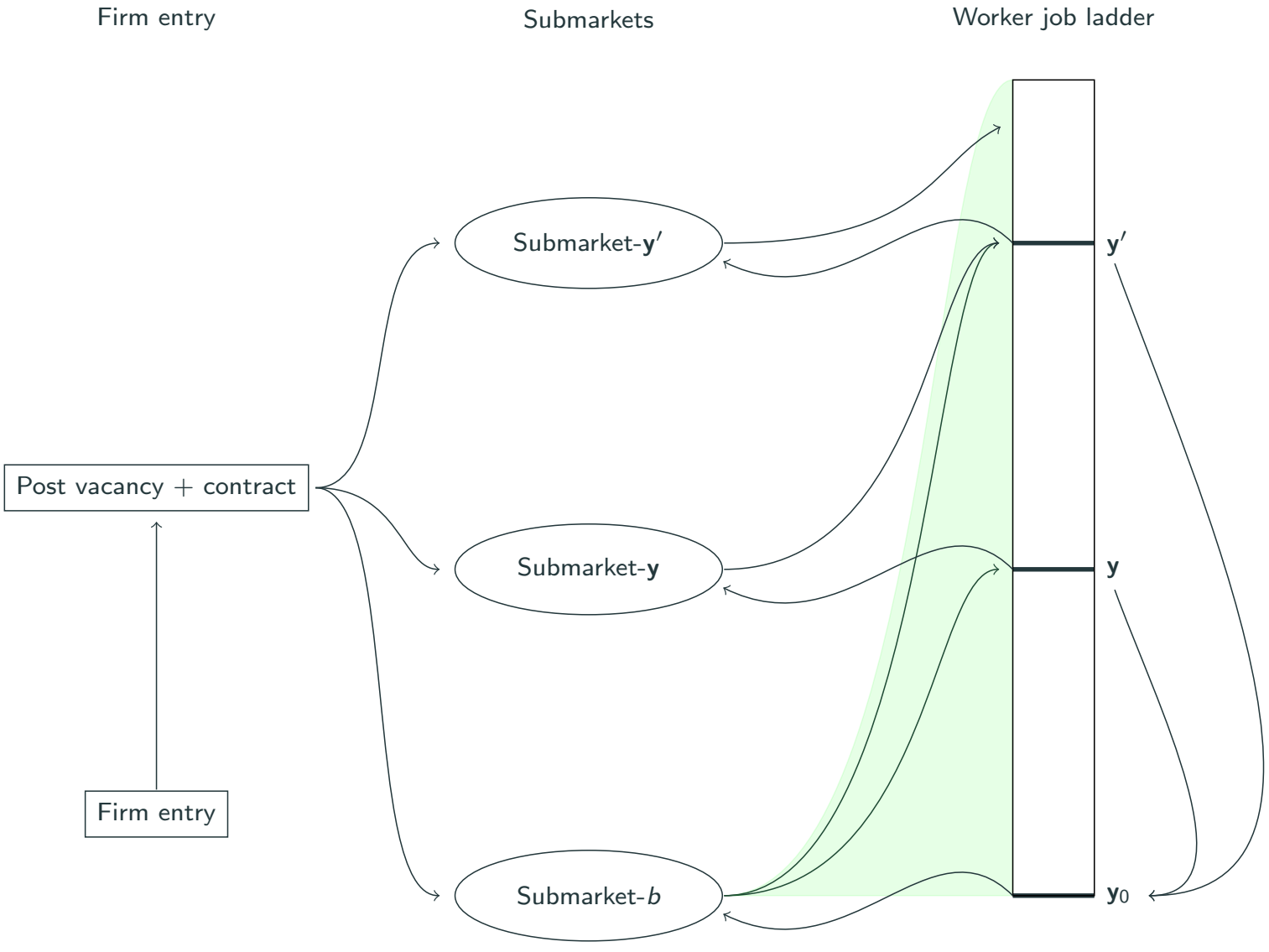
Model Components

- Risk neutral workers of different I types chose endogenous search effort and which market to search in
- Tax function linear in the worker's gross wage w:

$$T(w) = tw - t_0,$$

- Upon meeting via a matching function, a worker-firm pair draw $\mathbf{y} = (y_p, y_z)$ (y_p is productivity and y_z is amenity)
- If a match is formed, the worker enjoys a utility flow of $(1-t)w + y_z + t_0 - c(e)$; the firm has profit flow $y_p - w$
- Firms post contracts (acceptance set, a wage schedule, and a search effort schedule) and workers direct their search to these sub-markets.

Model overview (for given worker-type)



Equilibrium characterization

Proposition (Competitive search equilibrium)

There is a competitive search equilibrium such that

1. *Submarket-*$\mathbf{y}$ *search effort maximizes joint surplus* $L(\mathbf{y})$
2. *A worker switches from a type-*$\mathbf{y}$ *to a type-*$\mathbf{y}'$ *job iff*

$$y_p(1-t) + y_z < y'_p(1-t) + y'_z$$

3. *Firms post vacancies and set wages by Hosios rule to maximize the expected income flow from a vacancy*
4. *Free entry: expected income from a vacancy covers entry and vacancy operation costs*

Equilibrium characterization (cont'd)

- With/without taxes and benefits, the eq'm stipulates that
  1. Search effort maximizes after-tax NPV match utility $L(\mathbf{y})$
  2. Job ranking maximizes after-tax NPV match utility $L(\mathbf{y})$
  3. Vacancy creation maximizes after-tax NPV match utility $L(\mathbf{y})$
- Constrained efficient laissez faire ($t = b = 0$) allocation:
  - Search externalities internalized
  - No fiscal externalities
- A tax and benefit system introduces fiscal externalities which result in deadweight losses
- Deadweight losses can be traced directly to distortionary effects of the tax and transfer system

Marginal deadweight losses

- Consider a marginal increase in the tax rate
  - Disposable worker income falls and the Government budget increases: *a pure transfer*
  - Behavioral and GE responses along job search, job ranking, and job creation margins
    - Effect on worker utility: *Only 2nd order effects (envelope theorem)*
    - Fiscal externality: Responses represent systematic shift away from activities that are taxed, reducing the tax base: *deadweight loss*
- The deadweight loss is a reduction in tax revenue (+ rising expenditures) from behavioral responses to a tax change

Partial deadweight loss from distorted job search effort

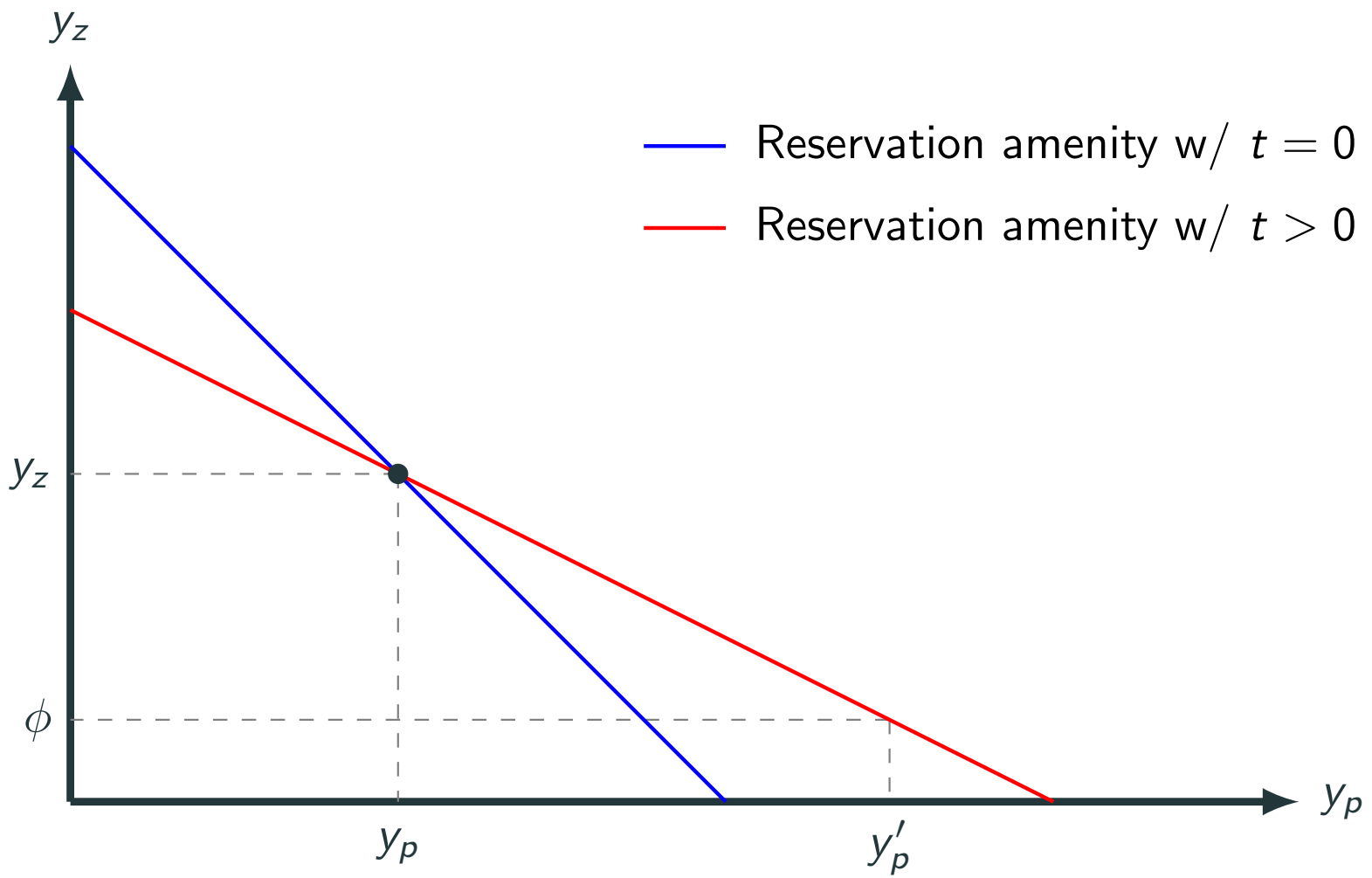
- Marginal search effort distortion in rung-$\mathbf{y}$ job spell:

$$\frac{\partial e(\mathbf{y})}{\partial t} = -\frac{p(\theta(\mathbf{y}))}{c''(e(\mathbf{y}))}\left[\frac{\beta(1-t)\Delta Y_p(\mathbf{y}) - (1-\beta)\Delta Y_z(\mathbf{y})}{1-t}\right]$$

- $\frac{\partial e(\mathbf{y})}{\partial t} < 0$ if there is a lot of scope for productivity growth.
- $\frac{\partial e(\mathbf{y})}{\partial t} > 0$ if there is a lot of scope for amenity growth.

- *Important*: Deviations in both directions are going to generate DWL

Distorted job ranking



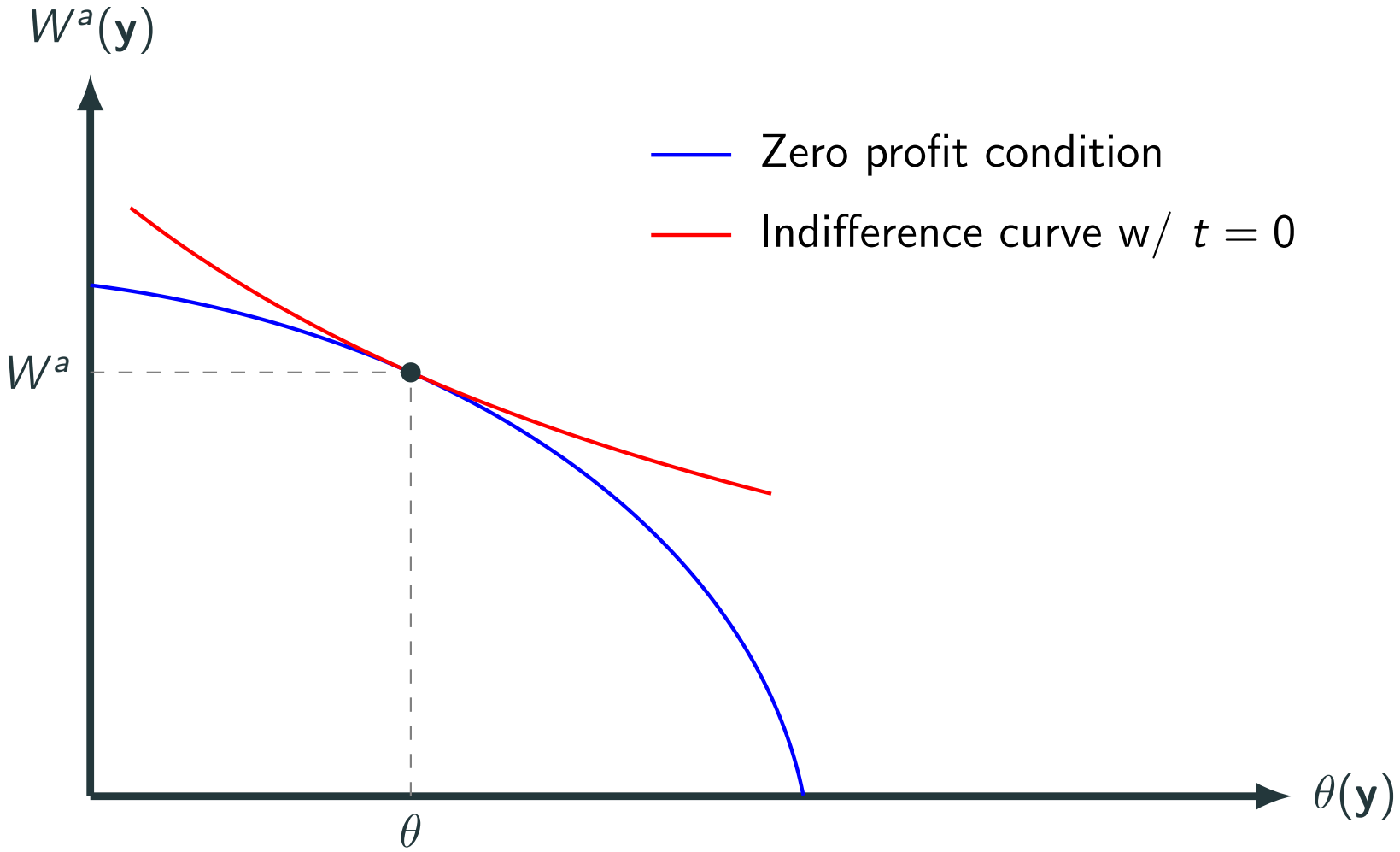
Partial deadweight loss from distorted vacancy creation

- Marginal tightness distortion in rung-$\mathbf{y}$ job spell:

$$\frac{\partial \theta(\mathbf{y})}{\partial t} = \frac{\theta(\mathbf{y}) \Delta Y_z(\mathbf{y})}{\beta(1-t)\left[(1-t)\Delta Y_p(\mathbf{y}) + \Delta Y_z(\mathbf{y})\right]} > 0$$

- If there is amenity growth then vacancy choices gets distorted as too many vacancies enter

Distorted vacancy creation ($\Delta Y_z(\mathbf{y}) > 0$)



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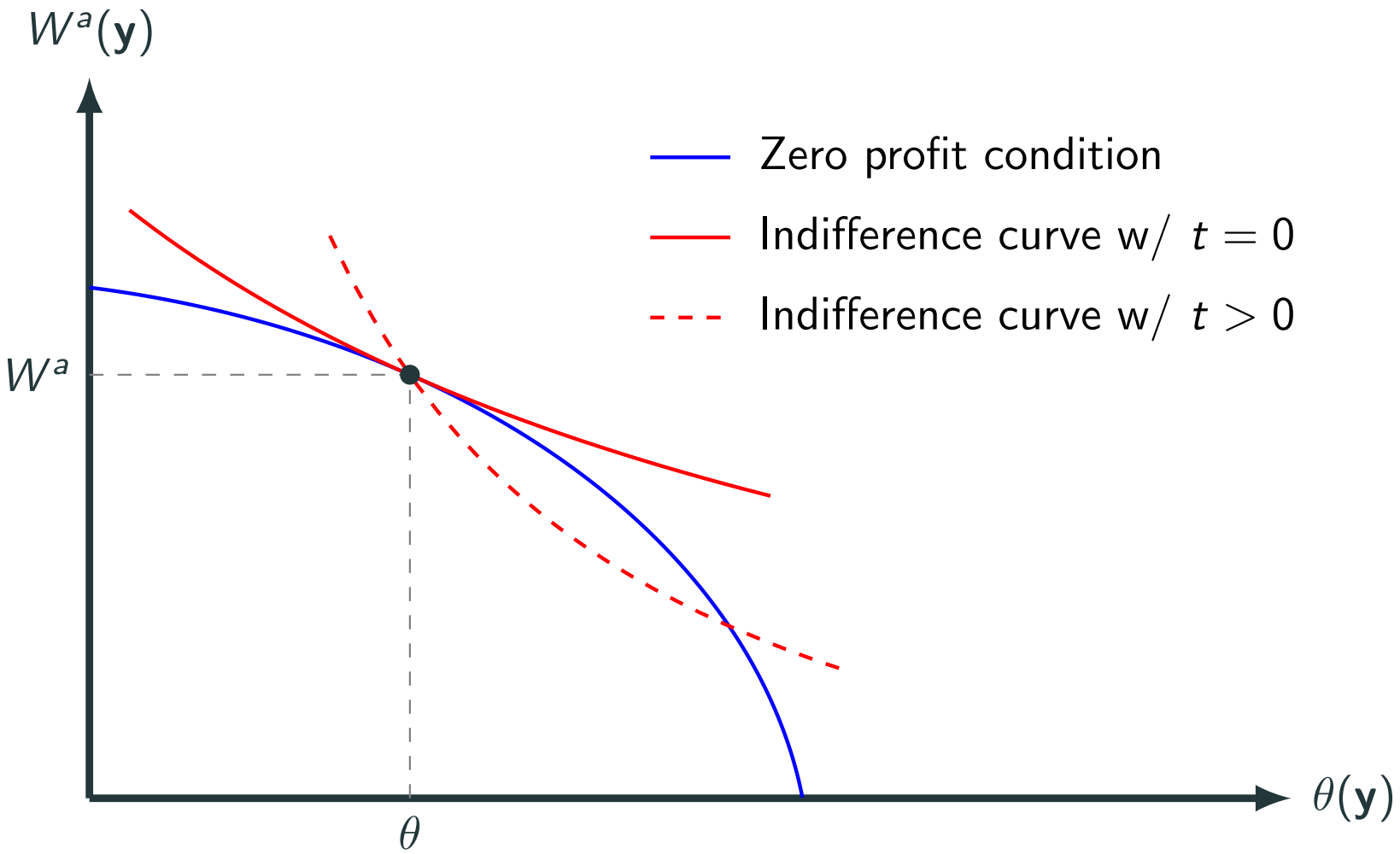

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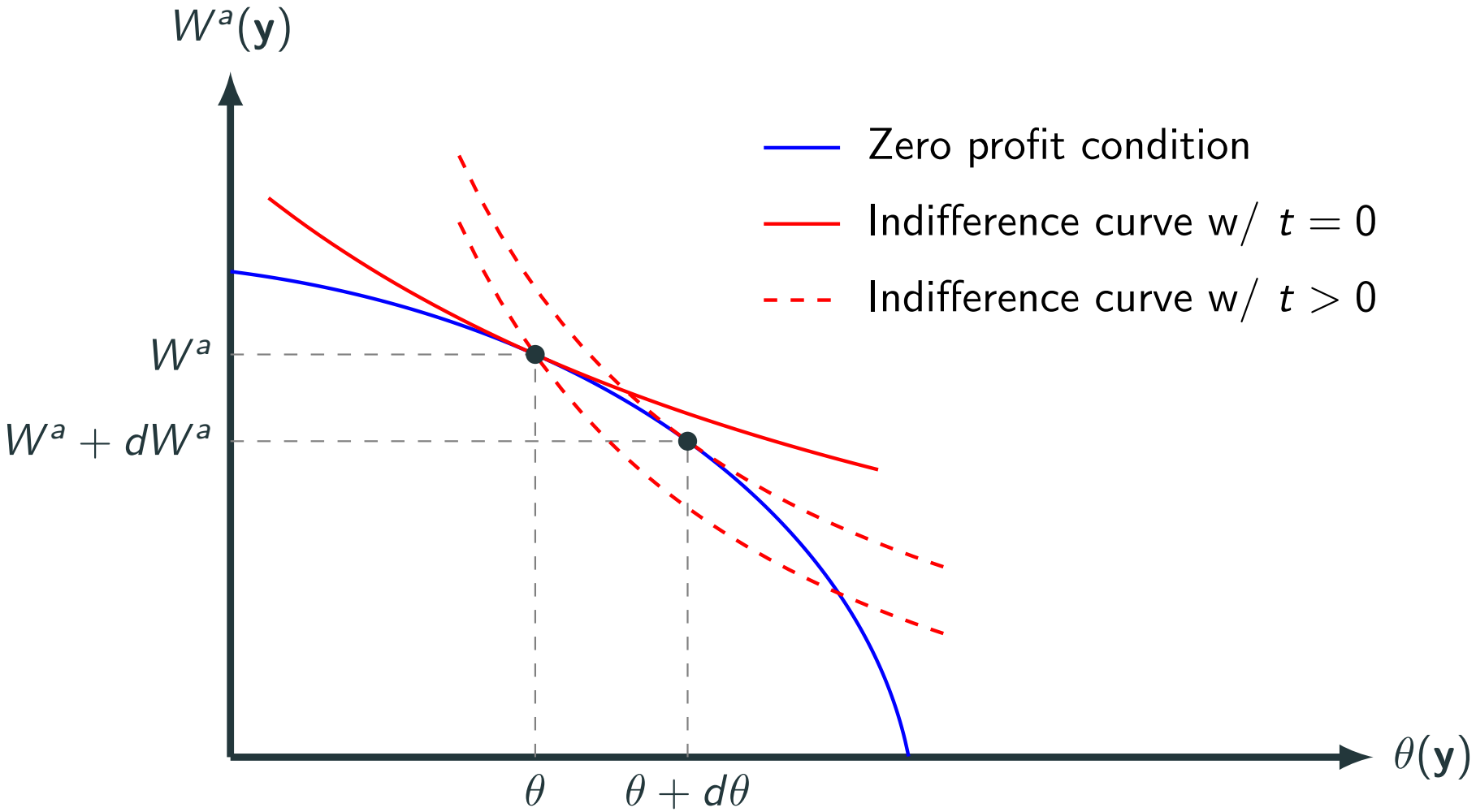


The planner's problem

- Consider an inequality-averse social planner concerned with the welfare of unemployed workers (Pissarides, 2000)

$$\max_{t,t_0} \sum_{i=1}^{I} \kappa^i \Phi(V_0^i + t_0) \quad \text{subject to} \quad \sum_{i=1}^{I} \kappa^i (tW_0^i - B_0^i - t_0) = 0$$

  where Φ is strictly increasing and concave

- Optimal t balances marginal gains and costs of redistribution:

$$\underbrace{-Cov\left(\Phi'(V_0^i + t_0), W_0^i\right)}_{\text{Gain from redistribution}} = \underbrace{\lambda \sum_{i=1}^{I} \kappa^i \left(-t\frac{\partial W_0^i}{\partial t} + \frac{\partial B_0^i}{\partial t}\right)}_{\text{Cost of redistribution}}$$

  where λ is the budget multiplier

Data and calibration

Data

- Population-wide, register-based Danish MEE data
- Use 1994-2003: Danish tax regime was (fairly) stable
- Select prime age, full-time, private sector
- Proceed with data on 1.6 mill. persons, and 190,000 firms
- Detailed simulation of individual marginal tax rates

Parameterization

- Worker-, productivity- and amenity-types $(\iota_w, \iota_p, \iota_z)$ uniform w/ 5 support points equidistanced on $[0, 1]$
- Higher worker-types are more productive when employed

$$y_p = \varrho_0 + \exp(\varrho_1 \iota_w + \varrho_2 \iota_p); \quad \varrho_0 > b; \varrho_1 > 0; \varrho_2 > 0$$

- All worker-types enjoy the same amenities

$$y_z = \exp(\varrho_z \iota_z); \quad y_{z,0} = 0$$

- All worker-types sample possibly correlated (Gaussian copula) (ι_p, ι_z)-pairs from common sampling distribution F
- Search disutility: $c(e) = \frac{c_0}{1+1/c_1} e^{1+1/c_1}$ w/ $c_0 = c_1 = 1$
- Measurement errors in wages: $\epsilon \sim \mathcal{N}(0, \sigma_\epsilon^2)$
- Cobb-Douglas matching function w/ elasticity $\beta = 0.5$

Fixed parameters

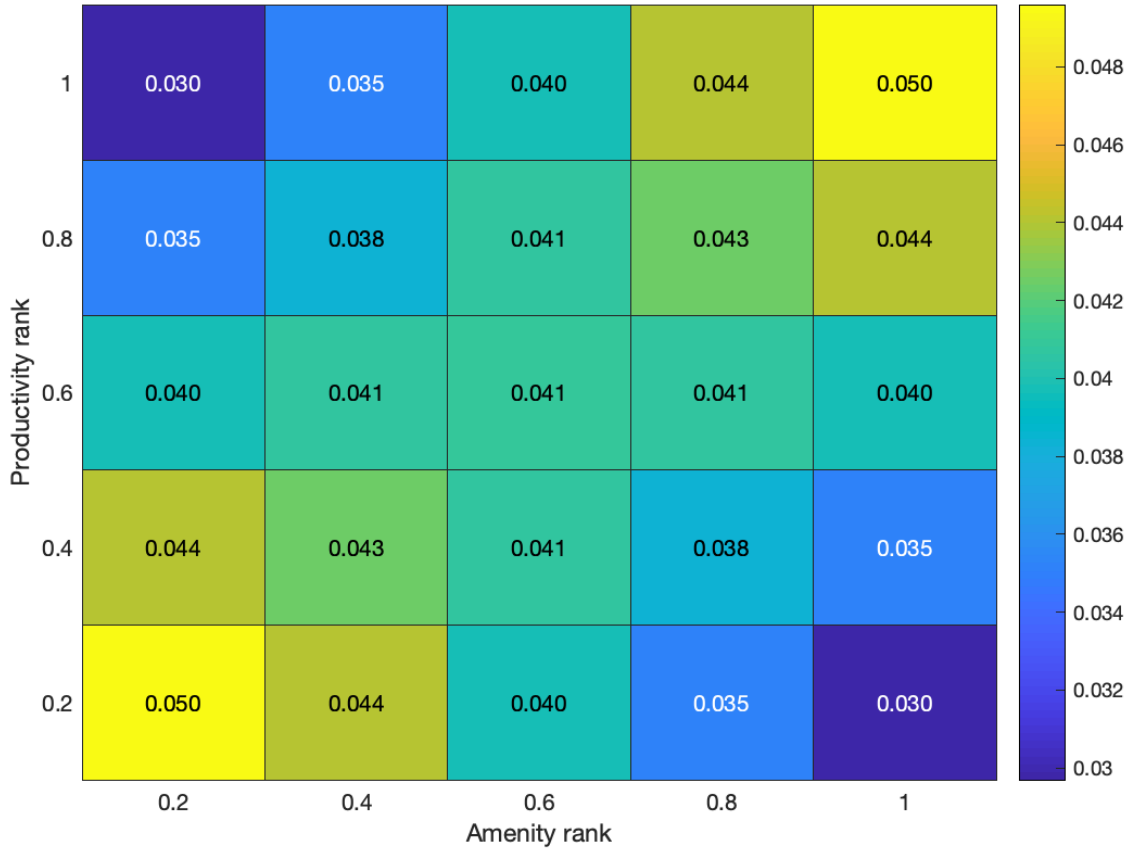
Parameter	Description	Value
r	Effective annual discount rate	0.05
β	Matching function elasticity	0.5
K	Entry cost	1
c^v	Vacancy operating cost	0.05
c_0	Scale parameter in search cost function	1
c_1	Elasticity of search cost function	1
b	Unemployment benefits	100
ϱ_3	Prod fct. parameter (complementarity)	0
τ	Profit tax rate	0.2
γ_K	Fraction deductible of K	1
γ_c	Fraction deductible of c^v	1
$y_{z,0}$	Amenities in unemployment	0

Calibrated parameters

Par.	Description	Value	Data Moment	Model	Data
A	Matching efficiency	0.054	Unemp. rate	0.050	0.050
δ_0	Sep. rate $s^i = \exp[\delta_0 + \delta_1(\iota_w^i - \iota_w^1)]$	-1.298	EN hazard ($<$ median wage)	0.210	0.211
δ_1	Sep. rate $s^i = \exp[\delta_0 + \delta_1(\iota_w^i - \iota_w^1)]$	-1.755	EN hazard ($>$ median wage)	0.092	0.094
ϱ_0	Prod. fct. $y_p = \varrho_0 + \exp(\varrho_1\iota_w + \varrho_2\iota_p)$	155	Average wage in DKK	184	184
ϱ_1	Prod. fct. $y_p = \varrho_0 + \exp(\varrho_1\iota_w + \varrho_2\iota_p)$	2.441	B/w-worker log wage var.	0.105	0.106
ϱ_2	Prod. fct. $y_p = \varrho_0 + \exp(\varrho_1\iota_w + \varrho_2\iota_p)$	4.054	W/n-wrk, b/w-job log wage var.	0.020	0.020
σ_ϵ	Measurement error var.	0.118	W/n-job log wage var.	0.010	0.010
$\overline{z}$	Amen. fct. $y_z = \exp(\varrho_z\iota_z)$	4.895	Prop. J2J w/ wage cut	0.372	0.391
ρ	Corr, Gaussian copula for $F(\mathbf{y})$	0.254	Wage growth after J2J	0.023	0.030
t	Labor income tax rate	0.643	Average marginal tax rate	0.643	0.643

Log-wage decomposition

Sampling distribution

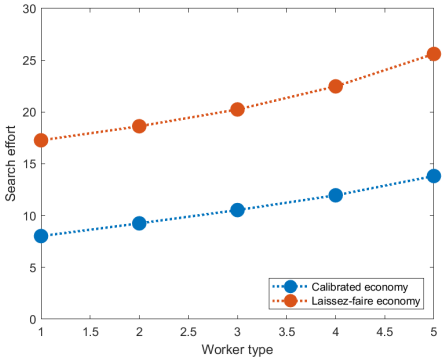


(y_p, y_z)-correlation in vacancies $= 0.105$

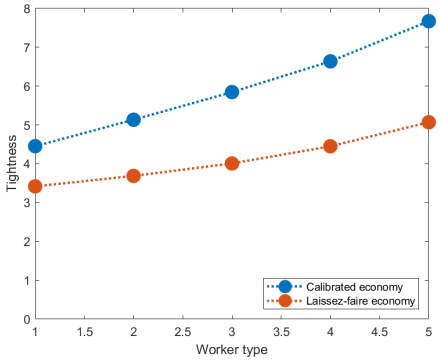
Comparison to laissez faire

Comparison to laissez-faire: Unemployment

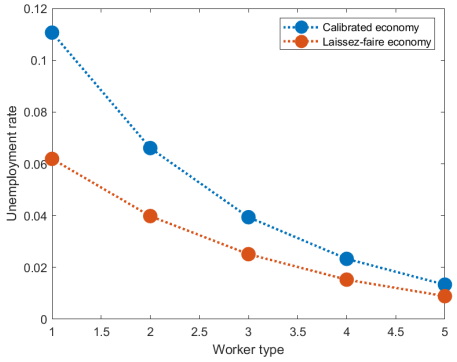
Search effort



Tightness



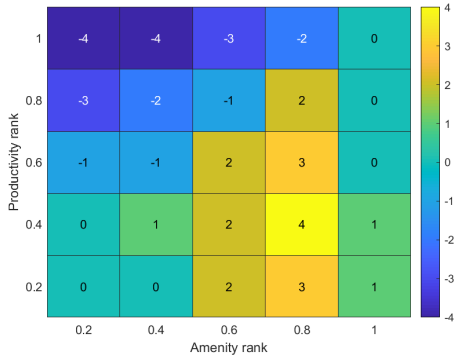
Unemployment rate



- Workers search less in the calibrated economy (exacerbated by UB)
- Tightness is higher (mitigated by UB)
- In total, the unemployment rate is higher (mostly low ability workers)

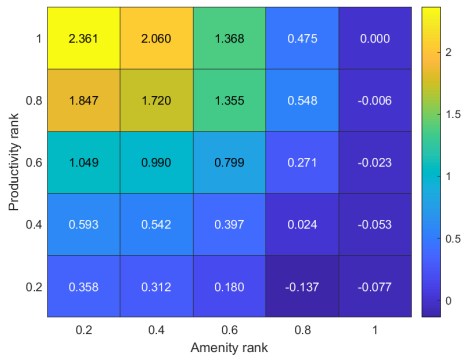
Comparison to laissez-faire: Employment

Job ranking

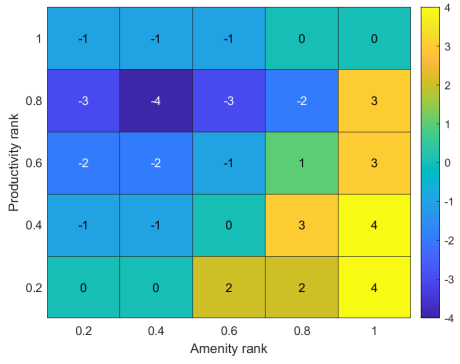


Search effort

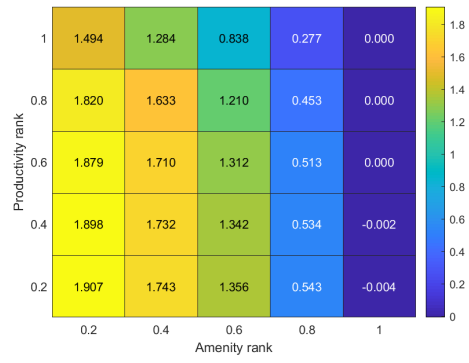
Worker type 1

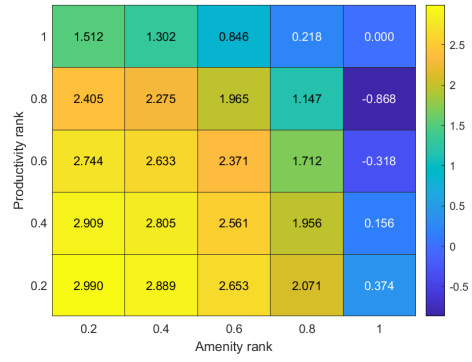


Worker type 5



Tightness

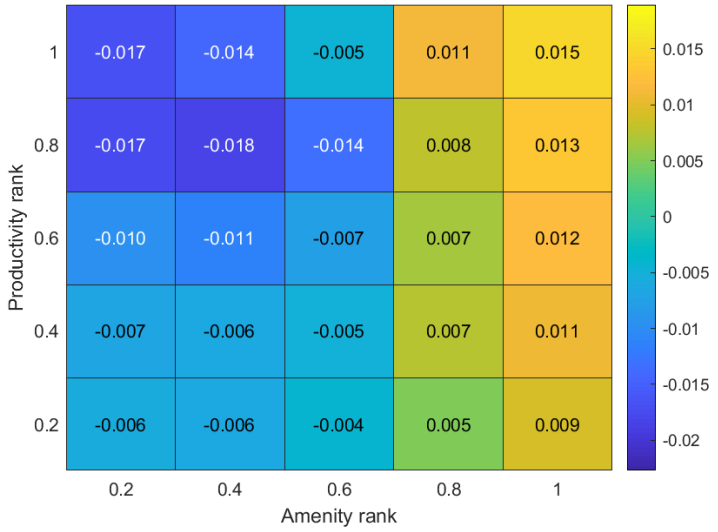




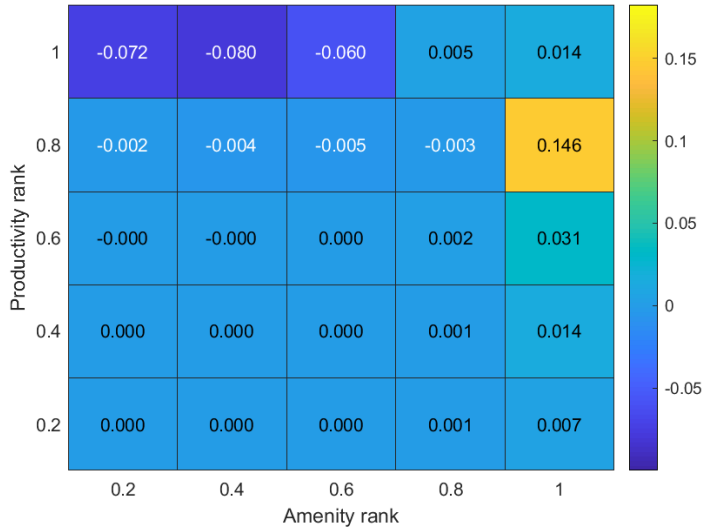
Comparison to laissez-faire: Employment

Worker allocation

Worker type 1



Worker type 5



Marginal deadweight loss decomposition

Decomposing the marginal deadweight loss

	Share of DWL	Share of tax base
Total	1.000	0.295
Job search effort distortions	0.409	0.121
Job ranking distortions	0.022	0.007
Vacancy creation distortions	0.569	0.168
Revenue side, total	1.040	0.307
Job search effort distortions	0.351	0.103
Job ranking distortions	0.022	0.007
Vacancy creation distortions	0.668	0.197
Expenditure side, total	−0.040	−0.012
Job search effort distortions	0.058	0.017
Vacancy creation distortions	−0.099	−0.029

The elasticity of taxable income wrt net-of-tax rate

- The *ETI* is a key parameter of interest in public economics
- We consider the elasticity of taxable *lifetime* income:

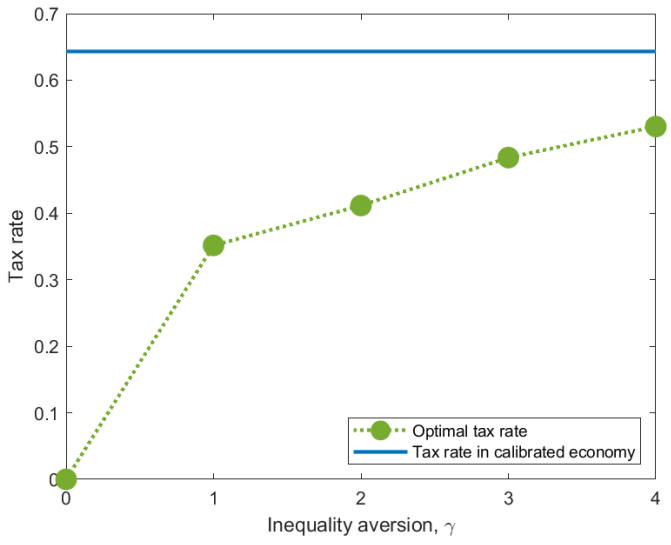
$$\epsilon_{\overline{W}_0,1-t} \equiv -\frac{\partial \overline{W}_0}{\partial(1-t)}\frac{1-t}{\overline{W}_0} = -0.307(1-0.643) = -0.11$$

- driven by real (hard-to-measure) economic responses:
  1. Job search effort: -0.037 (34%)
  2. Job ranking: -0.002 (2%)
  3. Vacancy creation: -0.070 (64%)
- Same order of magnitude to existing empirical ETI evidence
  - Saez et al. (2012): $ETI \approx -0.12$ to -0.40 (US)
  - Kleven and Schultz (2014): $ETI \approx -0.05$ to -0.12 (DK)

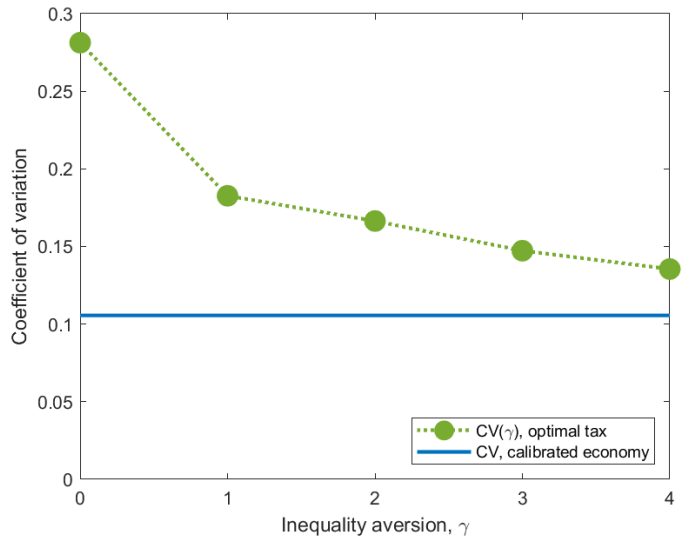
Taxation in planner economies

Optimal taxation in the planner economies

Tax rate



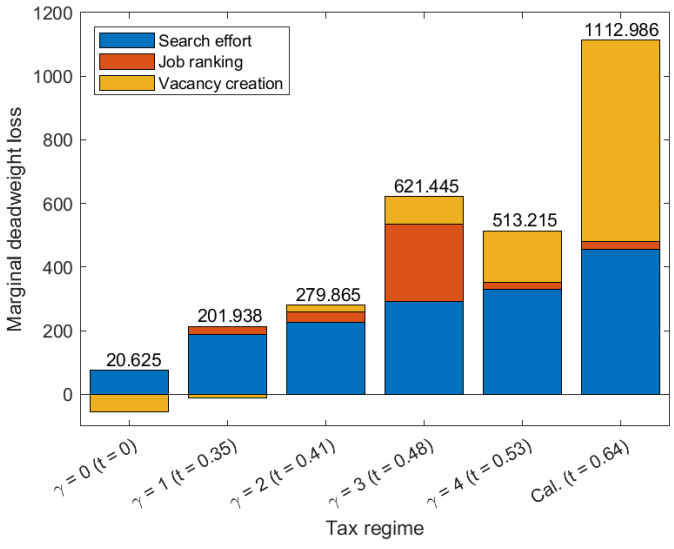
$CV(V_0)$



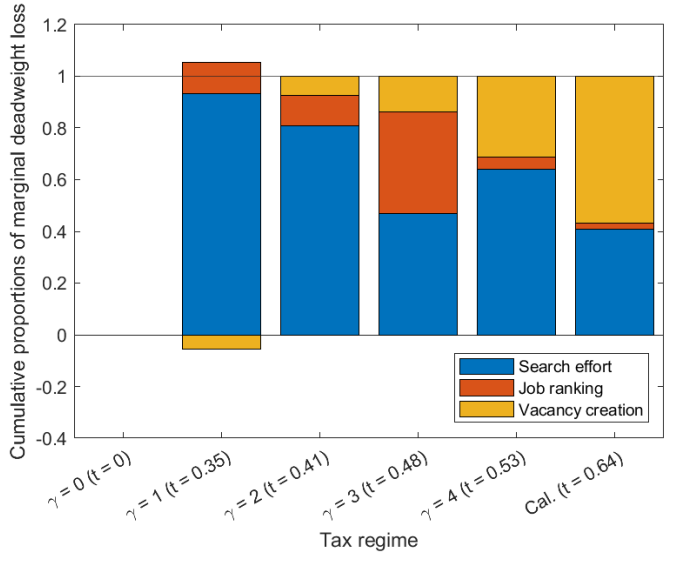
$$\Phi(x) = \frac{x^{1-\gamma} - 1}{1-\gamma}, \quad b = 100$$

Deadweight losses in the planner economies

Values



Proportions



Conclusion

What we have done

- Rich equilibrium job ladder model w/ amenities where workers search for jobs and firms search for workers
  - Established a competitive search equilibrium
  - Marginal deadweight losses and optimal linear taxation
- Calibrated the model to data from Denmark: $ETI = -0.11$ in addition to conventional distortions
  - Distorted job search effort: 40%
  - Distorted job ranking: 3%
  - Distorted vacancy creation: 57%
- Optimal tax analysis: Steeply rising deadweight loss from vacancy creation limits redistribution

What we want to work on

- Improve fit and identification
  - In particular regarding the correlation in the offer distribution
  - Amenity value of non-employment
- Optimal unemployment benefit provision
- Include non-neutral profit taxes
- Model extensions
  - Endogenous amenity types
  - Nonlinear labor taxes
  - Firm heterogeneity

Appendix

After-tax worker, firm and match values

- NPV utility of an worker in a $\mathbf{y}$-job, hired from a $\mathbf{y}^{\ell}$-job:

$$(r+s)V(\mathbf{y},\mathbf{y}^{\ell}) = w - tw + y_z - c(e) + sV_0 + ep(\theta)\int_{\mathcal{Y}_a}\left[V(\mathbf{y}',\mathbf{y}) - V(\mathbf{y},\mathbf{y}^{\ell})\right]dF(\mathbf{y}')$$

- The firm's NPV income from the job:

$$(r+s)J(\mathbf{y},\mathbf{y}^{\ell}) = y_p - w - ep(\theta)\int_{\mathcal{Y}_a} J(\mathbf{y},\mathbf{y}^{\ell})dF(\mathbf{y}')$$

- After-tax match value is $L(\mathbf{y}) \equiv V(\mathbf{y},\mathbf{y}^{\ell}) + (1-t)J(\mathbf{y},\mathbf{y}^{\ell})$:

$$(r+s)L(\mathbf{y}) = (1-t)y_p + y_z - c(e) + sL_0 + ep(\theta)\int_{\mathcal{Y}_a}\left[V(\mathbf{y}',\mathbf{y}) - L(\mathbf{y})\right]dF(\mathbf{y}')$$

Back

Log-wage variance decomposition

$$\underbrace{\frac{\sum_{i=1}^{N}\sum_{j=1}^{J_i}\sum_{t=1}^{T_{ij}}\left(w_{ijt}-\overline{w}\right)^2}{\sum_{i=1}^{N}\sum_{j=1}^{J_i}T_{ij}}}_{\text{Total variance}} = \underbrace{\frac{\sum_{i=1}^{N}\sum_{j=1}^{J_i}\sum_{t=1}^{T_{ij}}\left(w_{ijt}-\overline{w}_{ij}\right)^2}{\sum_{i=1}^{N}\sum_{j=1}^{J_i}T_{ij}}}_{\text{Within-job}}$$

$$+ \underbrace{\frac{\sum_{i=1}^{N}\sum_{j=1}^{J_i}\sum_{t=1}^{T_{ij}}\left(\overline{w}_{ij}-\overline{w}_{i}\right)^2}{\sum_{i=1}^{N}\sum_{j=1}^{J_i}T_{ij}}}_{\text{Within-worker, between-job}} + \underbrace{\frac{\sum_{i=1}^{N}\sum_{j=1}^{J_i}\sum_{t=1}^{T_{ij}}\left(\overline{w}_{i}-\overline{w}\right)^2}{\sum_{i=1}^{N}\sum_{j=1}^{J_i}T_{ij}}}_{\text{Between-worker}}$$

Back