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Introduction

- How do taxes affect labor supply and earnings behavior?
  - Most find intensive margin elasticities near zero (Heckman 1993, Blundell and MaCurdy 1999, Saez et al 2009)
  - Literature assumes that workers may freely choose labor supply
  - Two factors prevent workers from choosing labor supply freely:
    - Search costs in finding optimal job
    - Constraints imposed by firms (e.g. hours constraints)
  - Because of these frictions, workers may not reoptimize in response to tax changes of small size and scope in short run

→ Micro elasticity estimates may be attenuated relative to elasticities relevant for macro comparisons
Overview

• Derive three testable predictions about how adjustment costs and hours constraints affect micro labor supply elasticity estimates.

• Test predictions using an administrative tax panel for the population of Denmark.

• Find that standard micro methods of estimating elasticities on this dataset yields elasticities close to zero.

• But accounting for frictions produces sharp evidence of larger elasticities and explains why standard approach is biased.

• Calibration suggests that micro elasticity estimates understate the macro elasticities by an order of magnitude.
Model with Search Costs and Endogenous Institutional Constraints

- Two types of labor supply models in existing literature
  - Neo-classical: workers freely choose hours
  - Hours constraints: wage-hours packages determined by firms’ production technologies (Rosen 1976, Blundell et al. 2008)
- This paper: model of endogenous hours constraints
  - Wage-hours packages offered by firms reflect workers’ aggregate preferences
  - But workers face search frictions, so each worker is not at his individual optimum
Model Setup

- **Workers**: Constant elasticity quasi-linear utility function

  \[ u_i(c, h) = c - \alpha_i^{-1/\varepsilon} \frac{h^{1+1/\varepsilon}}{1+1/\varepsilon} \]

  - \( c \) is consumption and \( \alpha_i \) is an individual taste parameter

- **Smooth distribution** \( F(\alpha_i) \) in the economy

- **Firms**: CRS Leontief production function

  \[ \pi_j = pN_j \min\{h_j^1, \ldots, h_j^{N_j}\} - w_j \sum_{i=1}^{N_j} h_j^i \]

  - Offers (possibly heterogeneous) wage-hours packages \( \{h_j, w_j\} \)

  - Workers all produce goods sold a price \( p \)

  - Firm size \( N_j \) determined endogenously in equilibrium
Model Setup

• Search Frictions:
  • Workers initially draw job with wage-hours package \(\{h_0, w_0\}\) from distribution \(G(.)\) offered by firms
  
• Two ways to switch jobs:
  1. Switch to job with same hours but higher wage at no cost (e.g., no re-training required)
  2. Switch to different hours by paying a cost:
    • Draw new wage-hours package \(\{h', w'\}\) from \(G_e(.|h_i^*)\)
      • Draw centered at optimal job, \(E(h' | h_i^*) = h_i^*\)
      • Variance decreasing in effort, \(Var(h') = k(1 - e)\)
      • Search cost \(\Phi(e)\) weakly increasing in effort \(e\)
Model Setup

• Equilibrium:
  • Firm maximize profits
  • All workers paid same wage \( w_j = w = p \)
  • Workers choose optimal search effort (or not to search at all)
  • Workers only search if utility gain \( u_i(h^*) - u_i(h_0) > \Phi(e_{i^*}) \)
    \[ h_0 \notin [\underline{h}_i, \bar{h}_i] \]
  • Market clears: Supply equals demand at each hours level
  • Search process \( \mathcal{F}(\cdot) \) does not change the hours distribution
    \[ G(h) = \mathcal{F}(G(h)) \]
Estimating Elasticities: Benchmark Frictionless Model

- Special case: $\phi(\varepsilon) = 0$, all workers choose $h_i = h_i^*$

- Structural parameter $\varepsilon$ determines wage elasticity of labor supply

\[ \varepsilon = \frac{d \log h}{d \log (1 - \tau)} \]

- Two micro methods of identifying structural elasticity $\varepsilon$

1. Variation in tax rates over time. For individuals affected by tax change, observed hours elasticity w.r.t. net-of-tax wage equals $\varepsilon$

2. Variation in rates across tax brackets. Amount of bunching at kinks can be used to estimate $\varepsilon$
Bunching at Kink Points

Income/Labor Supply

Income distribution

Budget Set

Before Kink Introduction

After Kink Introduction

Consumption

Before Kink Introduction

After Kink Introduction
Bunching at Kink Points

Income distribution

Budget Set

Income/Labor Supply
Bunching at Kink Points

Income distribution

Budget Set

Before Kink Introduction

After Kink Introduction

Income/Labor Supply

- Consumption
- Before Kink Introduction
- After Kink Introduction
Bunching at Kink Points

“By the end of November some of my colleagues stop working. It does not pay anymore because they have reached the high tax bracket.”

- Danish construction worker
### Consumption

<table>
<thead>
<tr>
<th>Before Kink Introduction</th>
<th>After Kink Introduction</th>
</tr>
</thead>
</table>

### Income/Labor Supply

**Bunching at Kink Points**

Saez (2002): $\varepsilon \propto \frac{B}{\tau_2 - \tau_1}$

- **Red**: Consumption
- **Gray**: Before Kink Introduction
- **Blue**: After Kink Introduction
Baseline Case: Estimating Elasticities

- Special case: $\phi(\varepsilon) = 0$, all workers choose $h_i = h_i^*$

- Structural parameter $\varepsilon$ determines wage elasticity of labor supply

$$\varepsilon = \frac{d \log h}{d \log(1-\tau)}$$

- Two micro methods of identifying structural elasticity $\varepsilon$

1. Variation in tax rates over time. For individuals affected by tax change, observed hours elasticity w.r.t. net-of-tax wage equals $\varepsilon$

2. In non-linear tax system, use variation in rates across tax brackets. Examine amount of bunching at the kink.

$\Rightarrow$ How do frictions affect estimated elasticities?
Bunching with Search Frictions

- With hour constraints, there are two ways to locate at the kink
  
  1. *Individual Bunching*: Workers search for a job at the kink
  
  2. *Firm Bunching*: Draw job at kink to begin with
    - Signature of firm bunching: Even workers who do not face a kink bunch there

- Three predictions about observed elasticity measured from bunching at kink
Effects of Frictions on Observed Elasticities

• Three empirical predictions:

1. **[Size]** Larger kinks generate larger observed elasticities
   
   • Large kinks are more likely to induce workers to pay search costs and relocate to the kink
\[ U(c,h) = U^* - \phi \]

Slope = \((1 - \tau_2)w\)
\[
U(c,h) = U^* - \phi
\]

Slope = \( (1 - \tau_2)w \)

Slope = \( (1 - \tau_2')w \)
Effects of Frictions on Observed Elasticities

• Three empirical predictions:

1. [Size] Larger kinks generate larger observed elasticities
   • Large kinks are more likely to induce workers to pay search costs and relocate to the kink

2. [Scope] Kinks that affect a larger group of workers generate larger observed elasticities
   • Firms tailor jobs to aggregate preferences $\rightarrow$ more firm bunching at common kinks
Effects of Frictions on Observed Elasticities

• Three empirical predictions:

1. **[Size]** Larger kinks generate larger observed elasticities
   • Large kinks are more likely to induce workers to pay search costs and relocate to the kink

2. **[Scope]** Kinks that affect a larger group of workers generate larger observed elasticities
   • Firms tailor jobs to *aggregate* preferences $\rightarrow$ more firm bunching at common kinks

3. **[Correlation]** More firm bunching in sectors with greater individual bunching
   • In sectors of the economy where workers are more elastic, firms offer more jobs at the kink.
Micro vs Macro Elasticities

- Define macro elasticity as effect of difference in tax rates across economies on average hours of work:

\[
\hat{\epsilon}_{\text{MAC}} = \frac{E \log h_i(\tau'_1) - E \log h_i(\tau_1)}{\log(1 - \tau'_1) - \log(1 - \tau_1)}
\]

- In frictionless model, observed elasticities coincide with structural elasticity irrespective of size and scope

  \[\rightarrow\text{ No difference between micro and macro elasticities}\]

- In our model, macro elasticity coincides with \( \epsilon \) even with frictions
  - But micro estimates are attenuated
  - Intuition: micro estimates identified from “fine tuning” of hours in response to tax changes or locating at kinks
DATA AND INSTITUTIONAL BACKGROUND

- Matched employer-employee panel data with admin tax records for full population
  - Income vars: wage earnings, capital and stock income, pension contributions
  - Employer vars: tenure, occupation, employer ID
  - Demographics: education, spouse ID, kids, municipality
  - Approximately 2.42 million people per year
Marginal Tax Rates in Denmark in 2000

Δlog(NTR) = -11%

Δlog(NTR) = -33%

Note: $1 \approx 6$ DKr
KEY FEATURES OF TAX SYSTEM 1994-2001

• Taxable income = wage earnings + net deductions
  
  • Wage earnings: double reported by firms and workers
  
  • Net deductions:
    
    • Non-wage income: gifts, awards, company cars
    
    • Deductions: pension contributions, some work expenses
  
• Question of shifting vs. "real" labor supply responses

• Top bracket cutoffs move over time
  
  • Indexed to two-year lagged earnings growth: tax policy set before earnings choices are made
Movement in Top Tax Cutoff Across Years

<table>
<thead>
<tr>
<th>Year</th>
<th>2000 DKR (1000s)</th>
<th>Nominal DKR (1000s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994</td>
<td>230</td>
<td>240</td>
</tr>
<tr>
<td>1995</td>
<td>240</td>
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<td>1996</td>
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<td>1997</td>
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<td>300</td>
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<td>2000</td>
<td>280</td>
<td>320</td>
</tr>
<tr>
<td>2001</td>
<td>280</td>
<td>340</td>
</tr>
</tbody>
</table>

Graph showing the movement in top tax cutoff across years, with lines for CPI Adjusted and Nominal values.
Income Distribution for Wage Earners Around Top Kink (1994-2001)

- Taxable Income Relative to Top Bracket Cutoff (1000s DKr)
- Frequency
Income Distribution for Wage Earners Around Top Kink (1994-2001)

Excess mass = \( B(\Delta \tau) \)
Income Distribution for Wage Earners Around Top Kink (1994-2001)

Excess mass ($b$) = 0.81
Standard error = 0.05
(a) Married Women vs. Single Men

Married Women
Excess mass \( (b) = 1.79 \)
Standard error = 0.10

Single Men
Excess mass \( (b) = 0.25 \)
Standard error = 0.04
(b) Teachers vs. Military

Teachers
Excess mass \( (b) = 3.54 \)
Standard error = 0.25

Military
Excess mass \( (b) = -0.12 \)
Standard error = 0.21

Taxable Income Relative to Top Bracket Cutoff (1000s DKr)
Taxable Income Distributions in 1994

Taxable Income Distributions for All Wage Earners and Married Women in 1994.
2000

Taxable Income (1000s DKR)

Frequency (all wage earners)

Frequency (married women)
Does the Bunch Track the Kink or Inflation?
1994 to 1997

Taxable Income (1000s DKR)

Frequency (married women)

Frequency (all wage earners)
Does the Bunch Track the Kink or Inflation?
1994 to 1997

1994 Cutoff, Inflation Adjusted

1994 Cutoff, Adjusted for Wage Growth

Taxable Income (1000s DKR)

Frequency (all wage earners)

Frequency (married women)
Does the Bunch Track the Kink or Inflation?  
1994 to 1997

1994 Cutoff, Inflation Adjusted

1994 Cutoff, Adjusted for Wage Growth

1997 Cutoff

Taxable Income (1000s DKR)
Does the Bunch Track the Kink or Inflation?  
1997 to 2001

1997 Cutoff, Adjusted for Wage Growth

Actual 2001 Cutoff

1997 Cutoff, Inflation Adjusted
LABOR SUPPLY RESPONSES VS. SHIFTING

- Does bunching reflect earnings responses or income shifting?
- Two mechanisms for income shifting
  1. Evasion: under-reporting of income to avoid higher tax
     - Kleven et al. (2009) audit study: no evasion in wage earnings
     - Could still have mis-reporting of non-wage income
     → Test: Bunching in wage earnings?
  2. Shift to nontaxable compensation (pension contributions)
     → Test: Bunching in pensions plus taxable income?
Distribution of Wage Earnings

Excess mass \( b = 0.68 \)
Standard error = 0.05
Excess mass ($b$) = 0.48
Standard error = 0.04
PREDICTION 1: Small vs. Large Tax Changes

• We have already examined the larger, top tax kink
  • Top Bracket Cutoff: $\Delta \log(NTR) \approx 30\%$

• Two sources of smaller tax variation:
  • Middle Bracket Cutoffs: $\Delta \log(NTR) \approx 10\%$
  • Small Tax Reforms

• Now estimate observed elasticities from bunching at smaller kinks and small tax reforms
Middle Tax Kink: All Wage Earners, Taxable Income Distribution

Excess mass \( (b) \) = 0.06
Standard error = 0.03

Predicted excess mass = 0.16
Standard error = 0.01
Middle Tax Kink: All Wage Earners, Wage Earnings Distribution

Excess mass \( (b) = -0.06 \)
Standard error = 0.03

Predicted excess mass = 0.14
Standard error = 0.01
Middle Tax Kink: Married Women, Taxable Income Distribution

Excess mass \((b) = 0.06\)
Standard error = 0.03

Predicted excess mass = 0.35
Standard error = 0.02
PREDICTION 1: Small vs. Large Tax Changes

• Tax Reforms
  • Many small reforms during period we study: 4% change in net-of-tax wage on average

• Methodology: Gruber and Saez (2002)
  • Regress 2-year income change on 2-year change in net-of-tax wage (1-MTR)
  • Instrument for actual change in (1-MTR) with simulated change holding fixed base year characteristics
  • Include 10-piece spline in income and various fixed effects
### Observed Elasticity Estimates Using Small Tax Reforms

**Dependent Variable: % Change in Labor Income:**

<table>
<thead>
<tr>
<th>Variable:</th>
<th>Subgroup:</th>
<th>All Wage Earners</th>
<th>Married Females</th>
<th>Married Fem. Professionals w/ High Exp.</th>
<th>Wage Earners &gt; 200K</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Change in NTR</td>
<td>(1)</td>
<td>-0.005 (0.003)</td>
<td>-0.007 (0.004)</td>
<td>0.002 (0.005)</td>
<td>0.001 (0.011)</td>
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<tr>
<td>Labor Income Spline</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Total Income Spline</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Year Fixed Effects</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Age Fixed Effects</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Region Fixed Effects</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Occupation Fixed Effs.</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender/Married FE</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample Size</td>
<td>11,512,625</td>
<td>8,189,920</td>
<td>3,136,894</td>
<td>156,527</td>
<td>7,480,900</td>
</tr>
</tbody>
</table>
Observed Elasticity vs. Size of Tax Change

Observed Elasticities

Log Change in Net-of-Tax Rate

Observed Elasticities

Log Change in Net-of-Tax Rate
Switchers from Top Tax to Middle Tax

**Excess mass \((b) = 0.54\)**

*Standard error = 0.08*

**Excess mass \((b) = 0.06\)**

*Standard error = 0.07*
PREDICTION 2: Firm Responses and Scope of Kinks

- Do tax incentives that affect a larger group of workers generate larger elasticities?
- Need variation in size of group affected by a tax change
  - Exploit variation in deductions and non-wage income across workers
  - Creates variation in effective location of top bracket cutoff (the labor income required to be just at the top bracket)
- We focus on two kinks:
  - Statutory top tax kink, faced by 60% of population
  - “Pension” kink, faced by 2.5% of population
Distribution of Net Deductions

Net Deduction (DKr)

Indivs with non-wage income
Indivs making pension contribs.
Distribution of Net Deductions Given Deductions > DKr 20,000

Net Deduction (DKr)

Frequency

Net Deduction (DKr)
PREDICTION 2: Firm Responses and Small vs. Large Groups

• Prediction 2.1: There is firm bunching at the statutory top tax cutoff
  • Firms should have excess propensity to structure jobs so that salaries are close to statutory top bracket cutoff because 60% of workers face that cutoff
  • Signature of firm bunching: bunching among people who do not face a given change in tax incentives

• Examine wage earnings distribution at occupation level because of prevalence of collective wage bargaining in Denmark

• Start with case study of one of the largest occupations: teachers
Wage Earnings Distribution: Teachers
Wage Earnings Distribution: Teachers with Deductions > DKr 20,000

This group starts paying top tax here.
Modes of Occupation-Level Wage Earnings Distributions

Modes of Wage Earnings Distributions Relative to Top Bracket Cutoff (1000s DKr)
PREDICTION 2: Firm Responses and Small vs. Large Groups

• Prediction 2.1: There is firm bunching at the common kink

• Prediction 2.2: More firm bunching at more common kinks
  • Compare between statutory and pension kinks
  • Focus on group that faces *neither* kink:
    • Deductions between 7,500 and 25,000
Wage Earnings Around Pension Kink: Deductions > 20,000

Excess mass \((b)\) = 0.70
Standard error = 0.20
Wage Earnings Around Pension Kink: Deductions Between 7,500 and 25,000

Excess mass ($b$) = -0.01
Standard error = 0.15
Wage Earnings Around Statutory Kink: Deductions Between 7,500 and 25,000

Excess mass \( b = 0.56 \)

Standard error = 0.10
PREDICTION 2: Firm Responses and Small vs. Large Groups

• Prediction 2.1: There is firm bunching at the common kink

• Prediction 2.2: More firm bunching at common kink

• Prediction 2.3: Larger observed elasticity at more common kinks
  
  • Bunchers set wage earnings + deductions = top kink
  
  • Need exogenous variation in deductions to isolate bunching through earnings margin

• Identification: Split pop. into gender-age-married-year groups

  • Calculate fraction of each group with |net ded.| < 7500

  • Use this group average as a proxy for how “common” is an individual’s level of deductions

• Calculate elasticity estimate from bunching for these groups
Observed Elasticities vs. Scope of Tax Kink

Observed Elasticity from Bunching at Top Kink

Fraction of Group with \(|\text{Net Deductions}| < 7500\)
Dynamics: Movement with the Kink

• Why do individuals move with the kink despite search frictions?
  • Firm bunchers move with the kink because firm changes salaries for all workers
  • Individual bunchers do *not* move with the kink because of search costs

→ Should see different individual bunchers at kink in each year

• Test by examining probability of tracking movement in kink
  • Define indicator for change in earnings from year $t$ to $t+2$ within DKKr 7,500 of change in top tax bracket from $t$ to $t+2$
Dynamics of Earnings Around the Statutory Kink

% with Earnings Tracking Movement in Top Kink vs. Wage Earnings Relative to Statutory Kink (1000s DKR)
Dynamics of Earnings around Pension Kink: Deductions > 20,000
PREDICTION 3: Correlation between Individual And Firm Bunching

- Intuitively, individual preferences drive the firm job distribution

- Test prediction by looking across occupations
  - Two-digit Danish ISCO codes
Correlation = 0.65  ($p < 0.001$)

Correlation between Individual and Firm Bunching
Female Wage Earners

Excess mass \((b) = 1.37\)
Standard error = 0.08
Male Wage Earners

Unweighted
Excess mass \((b) = 0.46\)
Standard error = 0.03

DFL Reweighted
Excess mass \((b) = 0.85\)
Standard error = 0.09
Self-Employed

• Thus far, we have looked only at wage earners

• Self-employed do not face search frictions or hours constraints
  • Can more easily adjust earnings, both by changing labor supply and by reporting/intertemporal shifting

• Serve as a “placebo test” for our findings
  • Three predictions should not hold for the self-employed
  • Size and scope of tax change should not matter
Self-Employed: Taxable Income Distribution around Top Tax Cutoff

Excess mass \((b) = 18.42\)  
Standard error = 0.42
Self-Employed: Taxable Income Distribution around Middle Tax Cutoff

Excess mass \((b) = 1.44\)
Standard error = 0.10
Excess mass \( (b) = 0.22 \)
Standard error = 0.47
Self-Employed: Observed Elasticities vs. Scope of Tax Changes

Fraction of Group with $|\text{Net Deductions}| < 7500$
Calibration

- What do our micro estimates tell us about the macro elasticity?
  - Ideal experiment: Infinite tax change for a very small group

- Instead, we partially identify our model to bound the magnitude of the attenuation of the elasticity

- Key intuition: $\varepsilon$ controls the utility loss of deviating from optimum
  \[ u_i(h_i^*) - u_i(h) \approx -\frac{1}{2} \frac{1}{\varepsilon} wh_i^*(\Delta \log h)^2 \]

- Low $\varepsilon$ implies very convex loss function, inflexible labor supply

→ Upper bound on utility losses from search cost yield a lower bound on the structural elasticity
Calibration: Mechanics

• Calibrate tax system to match Danish economy

• Utility function: 
  \[ u_i(c, h) = c - \alpha_i^{-1/\varepsilon} h^{1+1/\varepsilon} \]

• Fit heterogeneous tastes to match income distribution away from the kink

• Parametric assumptions:

  Distribution of new draw: 
  \[ G_e(h' | h_i^*) = e \lim_{\lambda \to 0} N(h_i^*, \lambda) + (1 - e) N(h_i^*, \sigma) \]

  Search cost: 
  \[ \Phi_i(e) = \phi \cdot c_i^* \cdot (1 + e^\gamma) \]

• Fit the remaining parameters \( \{\phi, \sigma, \gamma, \varepsilon\} \) from the data
Excess Mass at the Middle and Top Kinks

Simulated Excess Mass ($b$)

$\phi = 0.06$, Top Kink

Empirical Estimate, Top Kink

$\phi = 0.06$, Middle Kink

Empirical Estimate, Middle Kink
Lower Bound on the Structural Elasticity

Average Utility Loss as a Fraction of Optimal Consumption ($\delta$)

Lower Bound on Structural Elasticity ($\varepsilon$)
Conclusion

• Search costs and institutional constraints attenuate short run behavioral responses substantially

• Demonstrated the effects of size and scope on elasticity

• Standard method of estimating elasticities using small tax reforms on same data yields close-to-zero elasticity estimate

• If we assume utility loss from frictions is less than 5% of optimal consumption, 0.25 is a lower bound on consumption

• May help explain why macro cross-country comparisons find larger elasticities (Prescott 2004, Davis and Henrekson 2005)
Conclusion: Potential Policy Implications and Future Work

• Welfare consequences of tax policies can be very different in the presence of frictions

• Suppose individuals have heterogeneous elasticities and must coordinate on hours choices

  → long run efficiency cost of taxing one group of workers differs from that implied by their own elasticities

• Optimal taxation in the presence of frictions

• Effect of frictions on other behavioral responses and the interpretation of other quasi-experimental estimates
Survey Evidence on Knowledge About Middle and Top Tax Cutoffs

Percent of Survey Responses

Income (1000 DKr)

Perceived Middle Tax Cutoff
Perceived Top Tax Cutoff