• Net government saving $\approx -1$ $\text{Trillion}$ (in 2018)
  
  ○ Current receipts: 5.6T
  
  ○ Current expenditures: 6.7T
The Macroeconomics of US Public Finance

- Net government saving $\approx -1 \text{ } \text{\$Trillion}$
  - Current receipts: $5.6\text{\$T}$
  - Current expenditures: $6.7\text{\$T}$

- Untaxed business income $\approx 1 \text{ } \text{\$Trillion}$
  - Income reported to IRS: $3.2\text{\$T}$
  - Estimate of true: $4.2\text{\$T}$
Net government saving $\approx -1$ $\text{Trillion}$

- Current receipts: 5.6T
- Current expenditures: 6.7T

Untaxed pass-through income $\approx 700$ $\text{Billion}$

- Income reported to IRS: 1.3T
- Estimate of true: 2T
The Macroeconomics of US Public Finance

- Net government saving $\approx -5.4\%$ GDP
  - Current receipts: 27\%
  - Current expenditures: 33\%

- Untaxed pass-through income $\approx 3.4\%$ GDP
  - Income reported to IRS: 6.4\%
  - Estimate of true: 9.8\%
The Macroeconomics of US Public Finance

- Net government saving $\approx -5.4\%$ GDP
  - Current receipts: $27\%$
  - Current expenditures: $33\%$

- Untaxed pass-through income $\approx 3.4\%$ GDP
  - Income reported to IRS: $6.4\%$
  - Estimate of true: $9.8\%$

$\Rightarrow$ Prompting more funding for IRS enforcement
Greater IRS Enforcement

- **Inflation Reduction Act:**
  - 80 billion over 10 years
  - Enforcement budget roughly doubled

- **Predicted returns on investment (ROI):**
  - CBO/JCT (2021): 5–9$
  - Boning et al (2023): 5–12$
This Paper

- First step before using IRS micro data
  - Use public IRS compliance data (TCMP/NRP)
  - Develop dynamic GE model of tax evasion
  - Compare higher tax vs enforcement counterfactuals

- Useful for next steps
  - Data: expand collection to business filings
  - Theory: add transition dynamics and welfare analysis
What’s New?

- Factors relevant for *dynamics of tax evasion*
  - Loss of *sweat capital* (eg, reputation, brands, etc)
  - Recovery of *back taxes*

- Why relevant?
  - Impacts business dynamics and productivity
  - Amplifies precautionary motives

⇒ Economies with higher tax vs enforcement different
IRS Compliance Data
IRS Compliance Data

- Tax gap = random audits + DCE adjustments

- Random audits:
  - Taxpayer compliance measurement program, 1962–88
  - National research program, 2000–present

- Detection controlled estimation (DCE) adjustments:
  - Scale up recommendations of all examiners
  - Use data from examiners with largest adjustments
### How Big is the Tax Gap?

<table>
<thead>
<tr>
<th>Gross tax gap</th>
<th>2001</th>
<th>2011</th>
<th>2021</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>billions of 2023$</td>
<td>567</td>
<td>575</td>
<td>763</td>
</tr>
<tr>
<td>% of GDP</td>
<td>3.3</td>
<td>2.7</td>
<td>2.9</td>
</tr>
<tr>
<td>Gross tax gap</td>
<td>2001</td>
<td>2011</td>
<td>2021</td>
</tr>
<tr>
<td>-----------------------</td>
<td>------</td>
<td>------</td>
<td>------</td>
</tr>
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</tbody>
</table>

What is the Main Source of the Gap?
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<thead>
<tr>
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<td>3.3</td>
<td>2.7</td>
<td>2.9</td>
</tr>
<tr>
<td>Source share:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Underreporting</td>
<td>83</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>Underpayment</td>
<td>10</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>Nonfiling</td>
<td>7</td>
<td>8</td>
<td>11</td>
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</tbody>
</table>
What is the Main Source of Underreporting?

<table>
<thead>
<tr>
<th>Source share</th>
<th>2001</th>
<th>2011</th>
<th>2021</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business</td>
<td>62</td>
<td>55</td>
<td>55</td>
</tr>
<tr>
<td>Wages &amp; salaries</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Other</td>
<td>34</td>
<td>42</td>
<td>43</td>
</tr>
</tbody>
</table>
How Widespread is Cheating?

- Evidence from NRP random-audit studies (no DCE)
  - All owners—ranked by reported incomes
  - Sole proprietors—ranked by understated tax

- Reveal same patterns
  - Cheating is widespread
  - Few owners account for most cheating
Proprietors Ranked by Understated Taxes

Understated Tax Amounts (in thousands of 2023$)

Percentile (excluding compliant 39%)

25th  50th  75th  90th  95th  98th
Proprietors Ranked by Understated Taxes

<table>
<thead>
<tr>
<th>Percentile (excluding compliant 39%)</th>
<th>Understated Tax Amounts (in thousands of 2023$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25th</td>
<td>$449</td>
</tr>
<tr>
<td>50th</td>
<td>$1,485</td>
</tr>
<tr>
<td>75th</td>
<td>$4,155</td>
</tr>
<tr>
<td>90th</td>
<td>$10,210</td>
</tr>
<tr>
<td>95th</td>
<td>$18,219</td>
</tr>
<tr>
<td>98th</td>
<td>$33,520</td>
</tr>
</tbody>
</table>
Cumulated Understated Taxes

Cumulative Understated Taxes (in billions of 2023$)

Percentile (excluding compliant 39%)

25th  50th  75th  90th  95th  98th  100th
Nonpecuniary Motives for Compliance

- TAS surveys intended to elicit nonpecuniary motives

- How?
  - Construct samples of sole proprietors
  - Use DIF scores indicating likelihood of audit
  - Group proprietors by DIF score
  - Compare responses of low-DIF and high-DIF groups
TAS Survey Main Results

• Compare lowest and highest compliance groups

• Where similar:
  ◦ Agree tax rules complicated
  ◦ Know consequences of underreporting
  ◦ Profess moral obligation to pay taxes

• Where different:
  ◦ High-compliance more trusting in IRS/govt
  ◦ High-compliance rely more on preparers
Does Evasion Occur Across Income Distribution?

- Evidence from NRP random-audit studies (no DCE)
  - Available publicly only for total incomes
  - Shows underreporting across the distribution
- Estimates of very top depend on DCE adjustments
Shares of Unreported Total Incomes (no DCE)
Recap: Lessons from IRS Data

- Gross tax gap large and $\approx 3\%$ of GDP over time
- Underreporting is main source of tax gap
- Underreporting by business owners is most of that
- Underreporting is widespread but concentrated
- Underreporting occurs across the income distribution
- Economic deterrence is only one factor driving compliance
Theory
Key Factors

- Occupational choice: paid- or self-employment
- Taxpayer types: always compliant or not
- Noncompliance source: business income underreporting
- Dynamics of tax evasion:
  - Loss of reputation, business brands, customers
  - Recovery of back taxes

⇒ Extends standard model of economic deterrence
Occupational Choice

- Choose business $b$ or work $w$

\[ V(s) = \max \{ V^b(s), V^w(s) \} \]

\[ V^i(s) = \max_x \left\{ U(c, \ell) + \beta \sum_{z', \epsilon'} \pi(z', \epsilon' | z, \epsilon) V(s') \right\} \]

where $s = (a, \kappa, d, z, \epsilon)$ and

- $a$: financial assets
- $\kappa$: sweat capital, eg, reputation, brands, etc
- $d$: back taxes, eg, accumulated unpaid taxes
- $z$: productivity in self-employment
- $\epsilon$: productivity in paid-employment
- $x = [a', \kappa', d', c_p, c_c, \ell, k_p, h_p, h_\kappa, e, c^r, y_b^r]$
Continuation Value

\[ \mathcal{V}(a', \kappa', d', z', \epsilon') \]

\[ = (1 - \Pi(d')) V(a', \kappa', d', z', \epsilon') \]

\[ \text{no audit} \]

\[ + \Pi(d') V(a' - f_a(d'), f_r(\kappa'), 0, z', \epsilon') \]

\[ \text{audit} \]
\[
\mathcal{V}(a', \kappa', d', z', \epsilon') = (1 - \Pi(d')) \mathcal{V}(a', \kappa', d', z', \epsilon') \\
\quad \text{no audit}
\]
\[
\quad + \Pi(d') \mathcal{V}(a' - f_a(d'), f_r(\kappa'), 0, z', \epsilon') \\
\quad \text{audit}
\]

Probability of audit
Continuation Value

\[ V(a', \kappa', d', z', \epsilon') = (1 - \Pi(d')) V(a', \kappa', d', z', \epsilon') \]

\[ + \Pi(d') V(a' - f_{a}(d'), f_{r}(\kappa'), 0, z', \epsilon') \]

Probability of audit and fines depend on \( d' \)
Continuation Value

\[ V(a', \kappa', d', z', \epsilon') = (1 - \Pi(d'))V(a', \kappa', d', z', \epsilon') \]

\[ + \Pi(d')V(a' - f_a(d'), f_r(\kappa'), 0, z', \epsilon') \]

Audit results in reputational losses
Business Owner’s Technologies

- Goods and services: \( y_p = z f_p(\kappa, k_p, h_p) \)
  - \( z \) = productivity in self-employment
  - \( \kappa \) = sweat capital
  - \( k_p \) = rented physical capital
  - \( h_p \) = owner time in production

- Sweat investment: \( x_\kappa = f_\kappa(h_\kappa, e) \)
  - \( h_\kappa \) = owner time in brand building
  - \( e \) = owner expenses
Business Owner’s Constraints

- Budget

\[ a' = \frac{[(1+r)a + y_b - T^b(y^b_b) - (1+\tau_c)(c_c + p_c p) + \chi]}{(1+\gamma)} \]

- Sweat capital

\[ \kappa' = \frac{[(1 - \delta_\kappa)\kappa + f_\kappa(h_\kappa, e)]}{(1 + \gamma)} \]

- Back taxes

\[ d' = \frac{[(1 - \delta_d)d + f_d(c^r)]}{(1 + \gamma)} \]

- Borrowing

\[ a' \geq f_a(d') \]
Business Owner’s Constraints

- Budget

\[ a' = \frac{[(1+r)a+y_b-T^b(y_b^r)-(1+\tau_c)(c_c+pc_p)+\chi]}{(1+\gamma)} \]
Business Owner’s Constraints

- Budget

\[
a' = \frac{[(1+r)a + y_b - T^b(y_b) - (1+\tau_c)(c_c + pc_p) + \chi]}{(1+\gamma)}
\]

↑ ↗

next period and current assets
Business Owner’s Constraints

- **Budget**

\[
a' = \left( (1+r)a + y_b - T^b(y_b^r) - (1+\tau_c)(c_c + p_c p) + \chi \right)/(1+\gamma)
\]

\[
\iff
\]

true and reported income

\[
y_b = py_p - (r + \delta)k_p - \epsilon, \quad y_b^r = y_b - (1 + \tau_c)c_r
\]
Business Owner’s Constraints

- **Budget**

\[ a' = \frac{[(1+r)a + y_b - T^b(y_b^r) - (1+\tau_c)(c_c + pc_p) + \chi]}{1+\gamma} \]

↑

↑

taxes on business and consumption
Business Owner’s Constraints

- Budget

\[ a' = \frac{[(1+r)a + y_b - T^b(y^b) - (1+\tau_c)(c_c + pc_p) + \chi]}{(1+\gamma)} \]

\[ \uparrow \quad \text{goods produced by C-corps and pass-thrus}, \quad c = \text{ces}(c_c, c_p) \]
Business Owner’s Constraints

• Budget

\[ a' = \frac{[(1+r)a+y_b-T^b(y_b^r)-(1+\tau_c)(c_c+pc_p)+\chi]}{(1+\gamma)} \]

↑ transfers
Business Owner’s Constraints

• Budget

\[ a' = \frac{((1+r)a + y_b - T^b(y'_b) - (1+\tau_c)(c_c + pc_p) + \chi)}{(1+\gamma)} \]

• Sweat capital

\[ \kappa' = \frac{((1 - \delta_\kappa)\kappa + f_\kappa(h_\kappa, e))}{(1 + \gamma)} \]
Business Owner’s Constraints

- Budget
  \[ a' = \frac{[(1+r)a+y_b-T^b(y_b^r)-(1+\tau_c)(c_c+p_{c_p})+\chi]/(1+\gamma) }{\text{sweat investment (shown earlier)}} \]

- Sweat capital
  \[ \kappa' = \frac{[(1-\delta_\kappa)\kappa + f_\kappa(h_\kappa, e)]/(1 + \gamma) }{\text{sweat investment (shown earlier)}} \]
Business Owner’s Constraints

- **Budget**

\[
a' = \frac{[(1+r)a + y_b - T^b(y^r_b) - (1+\tau_c)(c_c + p_c) + \chi]}{1+\gamma}
\]

- **Sweat capital**

\[
\kappa' = \frac{[(1 - \delta_\kappa)\kappa + f_\kappa(h_\kappa, e)]}{1 + \gamma}
\]

- **Back taxes**

\[
d' = \frac{[(1 - \delta_d)d + f_d(c^r)]}{1 + \gamma}
\]
Business Owner’s Constraints

- Budget

\[ a' = \left( (1+r)a + y_b - T^b(y_b^r) - (1+\tau_c)(c_c + pc_p) + \chi \right)/(1+\gamma) \]

- Sweat capital

\[ \kappa' = \left( (1 - \delta_{\kappa})\kappa + f_{\kappa}(h_{\kappa}, e) \right)/(1 + \gamma) \]

- Back taxes

\[ d' = \left( (1 - \delta_d)d + f_d(c^r) \right)/(1 + \gamma) \]

\[ \uparrow \]

current misreporting: \( y_b - y_b^r = (1 + \tau_c)c^r \)
Business Owner’s Constraints

- Budget

\[ a' = \frac{[(1+r)a + y_b - T^b(y_b^r) - (1+\tau_c)(c_c + p_c p) + \chi]}{1 + \gamma} \]

- Sweat capital

\[ \kappa' = \frac{[(1 - \delta_\kappa)\kappa + f_\kappa(h_\kappa, e)]}{1 + \gamma} \]

- Back taxes

\[ d' = \frac{[(1 - \delta_d)d + f_d(c^r)]}{1 + \gamma} \]
Business Owner’s Constraints

- Budget
  \[a' = \frac{[(1+r)a+y_b - T^b(y^*_b) - (1+\tau_c)(c_c+p_c) + \chi]}{(1+\gamma)}\]

- Sweat capital
  \[\kappa' = \frac{[(1 - \delta_\kappa)\kappa + f_\kappa(h_\kappa, e)]}{(1 + \gamma)}\]

- Back taxes
  \[d' = \frac{[(1 - \delta_d)d + f_d(c^r)]}{(1 + \gamma)}\]

- Borrowing
  \[a' \geq f_a(d')\]
Close the Model

- Standard dynamic program for workers, except
  - Sweat capital decays without use
  - Back taxes not forgiven

- Standard dynamic program for C corporations

- Public financing (G&S plus transfers) with
  - Taxes on consumption and all forms of income
  - Fines if caught evading taxes

(Details in slide deck appendix)
Qualitative Predictions
Predictions of Increased Enforcement

• Lower precautionary motives
  ◦ Financial assets used to pay future fines
  ◦ Borrowing constraints less binding

• Lower sweat capital stocks
  ◦ Brand assets lost with exposed tax evasion
  ◦ Business ages lower with more exit/entry
  ◦ Business productivity higher due to selection
Quantitative Results
Key Compliance Parameters

- Audit probability, $\Pi(d') = \pi$, $\pi$ varied
- Fines, $f_a(d) = \bar{p}d$, $\bar{p} = 4$
- Reputational cost, $f_r(\kappa) = 0$ if non-compliant
- Underreporting, $f_d(c^r) = \tau_b(1 + \tau_c)c^r$, $\tau_c = .065$, $\tau_b = .4$
- Back taxes depreciation, $\delta_d = 20\%$

*Note*: See paper for full calibration
Comparative Statics

- Vary audit probability $\pi$
- Record impacts for owners by type
## Fraction of Population

<table>
<thead>
<tr>
<th>Owner type:</th>
<th>2%</th>
<th>3%</th>
<th>5%</th>
<th>7%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-compliant</td>
<td>−21</td>
<td>−35</td>
<td>−60</td>
<td>−70</td>
</tr>
<tr>
<td>Compliant</td>
<td>11</td>
<td>23</td>
<td>43</td>
<td>45</td>
</tr>
<tr>
<td>All owners</td>
<td>−6</td>
<td>−9</td>
<td>−12</td>
<td>−17</td>
</tr>
</tbody>
</table>

⇒ Large compositional shift
## Financial Assets $(a)$

<table>
<thead>
<tr>
<th>Owner type:</th>
<th>2%</th>
<th>3%</th>
<th>5%</th>
<th>7%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-compliant</td>
<td>−4</td>
<td>−9</td>
<td>−29</td>
<td>−57</td>
</tr>
<tr>
<td>Compliant</td>
<td>5</td>
<td>12</td>
<td>28</td>
<td>39</td>
</tr>
<tr>
<td>All owners</td>
<td>−10</td>
<td>−18</td>
<td>−30</td>
<td>−36</td>
</tr>
</tbody>
</table>

⇒ Large drop in precautionary saving
Productivity ($z$)

<table>
<thead>
<tr>
<th>Owner type:</th>
<th>2%</th>
<th>3%</th>
<th>5%</th>
<th>7%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-compliant</td>
<td>9</td>
<td>16</td>
<td>25</td>
<td>27</td>
</tr>
<tr>
<td>Compliant</td>
<td>0</td>
<td>0</td>
<td>−1</td>
<td>−2</td>
</tr>
<tr>
<td>All owners</td>
<td>6</td>
<td>9</td>
<td>10</td>
<td>11</td>
</tr>
</tbody>
</table>

$\Rightarrow$ Large increase in productivity due to selection
## Sweat Capital ($\kappa$)

<table>
<thead>
<tr>
<th>Owner type:</th>
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<th>3%</th>
<th>5%</th>
<th>7%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-compliant</td>
<td>−9</td>
<td>−14</td>
<td>−37</td>
<td>−31</td>
</tr>
<tr>
<td>Compliant</td>
<td>12</td>
<td>13</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td>All owners</td>
<td>−4</td>
<td>−9</td>
<td>−15</td>
<td>−12</td>
</tr>
</tbody>
</table>

⇒ Large drop in business assets with more audits
## Business Age

<table>
<thead>
<tr>
<th>Owner type:</th>
<th>2%</th>
<th>3%</th>
<th>5%</th>
<th>7%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-compliant</td>
<td>−33</td>
<td>−50</td>
<td>−64</td>
<td>−68</td>
</tr>
<tr>
<td>Compliant</td>
<td>5</td>
<td>8</td>
<td>15</td>
<td>18</td>
</tr>
<tr>
<td>All owners</td>
<td>−30</td>
<td>−42</td>
<td>−49</td>
<td>−49</td>
</tr>
</tbody>
</table>

⇒ Large drop in age with more audits, less capital
Business Age Distributions ($\pi=1\%$ and $7\%$)

Compliant owners, if $\pi=1\%$
All owners, if $\pi=7\%$

Noncompliant owners, if $\pi=1\%$
Distributional Impacts

- Two rankings of interest:
  - By misreporting rates: \(100(y_b - y'_b)/y_b\)
  - By business receipts: \(py_p\)

- Looking for patterns of underreporting
  - Few owners account for most cheating
  - Cheating occurs across the income distribution
Rank Owners by Underreporting ($\pi = 2\%$)

<table>
<thead>
<tr>
<th>% Deviations</th>
<th>None</th>
<th>&lt;80</th>
<th>80-90</th>
<th>90-99</th>
<th>&gt;99</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business age</td>
<td>−37</td>
<td>−18</td>
<td>19</td>
<td>4</td>
<td>67</td>
</tr>
<tr>
<td>Financial assets</td>
<td>−40</td>
<td>−63</td>
<td>−30</td>
<td>−4</td>
<td>79</td>
</tr>
<tr>
<td>Sweat capital</td>
<td>−21</td>
<td>63</td>
<td>59</td>
<td>51</td>
<td>23</td>
</tr>
<tr>
<td>Productivity</td>
<td>7</td>
<td>11</td>
<td>14</td>
<td>13</td>
<td>−16</td>
</tr>
<tr>
<td>True income</td>
<td>−10</td>
<td>111</td>
<td>107</td>
<td>93</td>
<td>−7</td>
</tr>
<tr>
<td>% Owners</td>
<td>59</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>33</td>
</tr>
</tbody>
</table>

⇒ Concentrated, but too many able to get income to 0
Rank Owners by Receipts ($\pi = 2\%$)

<table>
<thead>
<tr>
<th>% Deviations</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business age</td>
<td>−21</td>
<td>6</td>
<td>−21</td>
<td>14</td>
<td>21</td>
</tr>
<tr>
<td>Financial assets</td>
<td>19</td>
<td>12</td>
<td>−1</td>
<td>−6</td>
<td>−23</td>
</tr>
<tr>
<td>Sweat capital</td>
<td>−57</td>
<td>−13</td>
<td>−15</td>
<td>36</td>
<td>49</td>
</tr>
<tr>
<td>Productivity</td>
<td>−21</td>
<td>−17</td>
<td>10</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>True income</td>
<td>−113</td>
<td>−68</td>
<td>5</td>
<td>72</td>
<td>104</td>
</tr>
<tr>
<td>% Underreporting</td>
<td>32</td>
<td>47</td>
<td>26</td>
<td>36</td>
<td>57</td>
</tr>
</tbody>
</table>

⇒ Cheating occurs throughout the size distribution
Policy Counterfactuals

• Two ways to raise same revenues
  ○ Higher enforcement: $\pi = 2\% \rightarrow \pi = 5\%$
  ○ Higher tax rate on business: $\tau_b = 40\% \rightarrow \tau_b = 47\%$

• Raise revenues by 3% relative to $\pi = 2, \tau_b = 40$ baseline
## Enforcement vs Taxation

<table>
<thead>
<tr>
<th>% Change in:</th>
<th>More Audits $\pi=5$ vs 2%</th>
<th>Higher Tax $\tau_b=47$ vs 40%</th>
</tr>
</thead>
<tbody>
<tr>
<td># of Owners</td>
<td>−7</td>
<td>−4</td>
</tr>
<tr>
<td>Non-compliant</td>
<td>−50</td>
<td>12</td>
</tr>
<tr>
<td>Compliant</td>
<td>29</td>
<td>−18</td>
</tr>
<tr>
<td>Business age</td>
<td>−28</td>
<td>16</td>
</tr>
<tr>
<td>Financial assets, $a$</td>
<td>−22</td>
<td>14</td>
</tr>
<tr>
<td>Sweat capital, $\kappa$</td>
<td>−11</td>
<td>6</td>
</tr>
<tr>
<td>Back taxes, $d$</td>
<td>−66</td>
<td>44</td>
</tr>
<tr>
<td>Productivity, $z$</td>
<td>6</td>
<td>−3</td>
</tr>
<tr>
<td>Business income, $y_b$</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>
Bottom Line

• Higher enforcement vs taxation
  ◦ Most evident in composition of businesses/owners
  ◦ Not evident in aggregate business income

• Need transitional dynamics to do proper welfare analysis
Next Steps

- Data: gather relevant IRS micro data
  - Current NRP studies only work with 1040
  - Want to expand analysis to business filings

- Theory: add transitional dynamics
  - Current analysis is steady state
  - Want to analyze Inflation Reduction provisions
  - Want to do full welfare analysis with transition
Appendix
Dynamic Program for Workers

- Workers choose $x = [a', c_p, c_c, \ell]$ to solve

$$V^w(s) = \max_x \{U(c, \ell) + \beta \sum_{z', \epsilon'} \pi(z', \epsilon'|z, \epsilon) V(s')\}$$

subject to

$$a' = [(1 + r)a + w\epsilon h_w - T^w(w\epsilon h_w) - (1 + \tau_c)(c_c + p\epsilon c_p) + \chi]/(1 + \gamma)$$

$$\kappa' = (1 - \lambda_\kappa)\kappa/(1 + \gamma)$$

$$d' = (1 - \lambda_d)d/(1 + \gamma)$$

$$1 = \ell + h_w$$
Dynamic Program for Corporations

- Corporations choose $x_c, n_c$ to solve

\[ V^c(k_c) = \max \left\{ (1 - \tau_d)d_c + \frac{1+\gamma}{1+r}V^c(k'_c) \right\} \]

subject to

\[ d_c = AF(k_c, n_c) - wn_c - x_c - \tau_p(y_c - wn_c - \delta_k k_c) \]
\[ x_c = (1 + \gamma)k'_c - (1 - \delta_k)k_c \]
\[ g + \chi + (r - \gamma)b = \tau_c \int (c_{ci} + p_{ci}) \, di + \]
\[ + \tau_d (y_c - wn_c - (\gamma + \delta_k)k_c - \tau_p (y_c - wn_c - \delta_k k_c)) \]
\[ + \tau_p (y_c - wn_c - \delta_k k_c) + \int T^n (w\epsilon_i n_i) \, di \]
\[ + \int T^b (y^{b}_{ri}) \, di + \int 1_i f_a (d_i) \, di \]