Marginal Cost of Public Funds in the Presence of Informality

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Introduction

- Raising tax revenue has distortionary consequences
  - Taxes on earnings distort labor supply choice
  - Taxes on capital income gains reduces capital accumulation
- Comparability of different taxes require standardized measures
- Marginal cost of public funds (MCF) measures the welfare cost of raising additional revenue
  \[ MCF_i = - \frac{\partial W/\partial \tau_i}{\partial R/\partial \tau_i} \]
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Literature Review

- MCF concept formalized by Browning (1976, *JPE*)
- Sandmo (1998, *JPubE*) on the effects of redistribution when there is heterogeneity
- Auriol and Warlters (2012, *JDE*) static impacts of informality
- Hashimzade and Myles (2012, *WP*) MCF in a standard neoclassical growth model
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Literature Review

- MCF concept formalized by Browning (1976, JPE)
- Dahlby (1998, JPubE) on the role of progressivity of taxation
- Sandmo (1998, JPubE) on the effects of redistribution when there is heterogeneity
- Kleven and Kreiner (2006, JPubE) on the implications of labor force participation
- Auriol and Warlters (2012, JDE) static impacts of informality
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Contribution

• Our paper is the first one to ... 
  • study the implications of the informal sector on MCF in a DSGE set-up
  • show the link between tax enforcement and MCF
  • address MCF for a wide array of functional forms and parameter spaces
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Model Environment

- DSGE economy with two sectors and a representative household (*à-la* Ihrig and Moe (2004, *JDE*)
  - Formal sector using standard Cobb-Douglas Production technology
  - Informal sector lacking physical capital and using labor-intensive technology
  - Government revenues are financed by distortionary taxes (capital, labor, consumption, . . .)
  - Formal sector to full, informal sector to *partial* taxation
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Household’s Problem

- Representative household solves

\[
\max_{\{C_t, K_{t+1}, L_t, N_{lt}, N_{Ft}\}} \sum_{t=0}^{\infty} \beta^t U(C_t, L_t)
\]

subject to

\[
N_{lt} + N_{Ft} + L_t = T
\]

\[
(1 + \tau_c) C_t + K_{t+1} = (1 - \delta) K_t + (1 - \tau_k) r_t K_t
\]

\[
+ (1 - \tau_n) w_{Ft} N_{Ft} + (1 - \rho \tau) (w_{lt} N_{lt} + \pi_{lt})
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N_{It} + N_{Ft} + L_t = T
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(1 + \tau_c)C_t + K_{t+1} = (1 - \delta)K_t + (1 - \tau_k)r_t K_t + (1 - \tau_n)w_{Ft} N_{Ft} + (1 - \rho \tau_i)(w_{It} N_{It} + \pi_{It})
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\]
The formal firm solves

\[
\max_{K_t, N_{Ft}} \pi_{Ft} = Y_{Ft} - r_t K_t - w_{Ft} N_{Ft}
\]

subject to

\[
Y_{Ft} = \theta_{Ft} K_t^\alpha N_{lt}^{1-\alpha}
\]

\[
K_t \geq 0, \quad N_{Ft} \geq 0
\]
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Informal Firm

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\max_{N_{lt}} \pi_{lt} = Y_{lt} - w_{lt} N_{lt}
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$$N_{lt} \geq 0$$
Competitive Equilibrium

Given the government policy variables \( \{\tau_c, \tau_i, \tau_k, \tau_n, \rho\} \), a competitive equilibrium of this two-sector model is a set of sequences of allocations \( \{C_t, L_t, K_{t+1}, N_{It}, N_{Ft}\}_{t=0}^{\infty} \) and prices \( \{w_{Ft}, w_{It}, r_t\}_{t=0}^{\infty} \) such that

1. Given the prices and policy, \( \{C_t, L_t, K_{t+1}, N_{It}, N_{Ft}\}_{t=0}^{\infty} \) maximizes representative agent’s life-time utility
2. Given the prices \( \{N_{It}, N_{Ft}, K_t\}_{t=0}^{\infty} \) solve the profit maximization problems
3. All markets clear
4. Government budget constraint holds:
\[
R = \tau_c C + \tau_k \alpha Y_f + \tau_n (1 - \alpha) Y_f + \rho \tau_i Y_i
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Equilibrium Results

- Assuming logarithmic utility $U(C_t, L_t) = \log(C_t) + \phi \log(L_t)$, Euler equation is:

$$\frac{C_{t+1}}{C_t} = \beta [(1 - \tau_k)\theta_F\alpha K_{t+1}^{\alpha-1} N_{Ft+1}^{1-\alpha} + 1 - \delta]$$

- No-arbitrage condition requires equal MPN in both sectors

$$(1 - \tau_n)\theta_F(1 - \alpha)K_t^\alpha N_{Ft}^{-\alpha} = (1 - \rho\tau)\theta_F \gamma N_{lt}^{\gamma-1}$$

- Physical capital next period then equals:

$$K_{t+1} = N_{Ft+1} \left[ \frac{(1 - \tau_k)\theta_F \alpha}{(1 + g_c)/\beta - 1 + \delta} \right]^{\frac{1}{1-\alpha}}.$$
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Equilibrium Results (cont’d)

- At the steady state, the closed-form interior solutions are:

\[
N_l = \left\{ \frac{(1 - \rho \tau) \gamma \theta_l}{(1 - \tau_n)(1 - \alpha) \theta_F} \left[ \frac{1}{\alpha(1 - \tau_k) \theta_F} \right]^\frac{\alpha}{1 - \alpha} \right\}^{\frac{1}{1 - \gamma}}
\]

\[
N_F = \frac{(T - N_l) \gamma (1 - \rho \tau) \theta_l N_l^{\gamma - 1} - \phi(1 - \rho \tau) \theta_l N_l^\gamma}{\gamma(1 - \rho \tau) \theta_l N_l^{\gamma - 1} + \phi[(\alpha(1 - \tau_k) + (1 - \alpha)(1 - \tau_n)) \theta_F (\frac{\alpha(1 - \tau_k) \theta_F}{1/\beta - 1 + \delta})^\frac{\alpha}{1 - \alpha} - \delta(\frac{\alpha(1 - \tau_k) \theta_F}{1/\beta - 1 + \delta})^\frac{1}{1 - \alpha} ]}
\]

\[
K = N_F \left[ \frac{(1 - \tau_k) \theta_F \alpha}{1/\beta - 1 + \delta} \right]^{\frac{1}{1 - \alpha}}
\]

\[
(1 + \tau_c) C = (1 - \tau_k) \alpha Y_F + (1 - \tau_n)(1 - \alpha) Y_F + (1 - \rho \tau) Y_i - \delta K
\]

\[
R = \tau_c C + \tau_k \alpha Y_f + \tau_n(1 - \alpha) Y_f + \rho \tau Y_i
\]
Equilibrium Results (cont’d)

- At the steady state, the closed-form interior solutions are:

\[
N_I = \left\{ \frac{(1 - \rho \tau) \gamma_I}{(1 - \tau_n)(1 - \alpha) \theta_F} \left[ \frac{1}{\beta} - 1 + \delta \right]^{\frac{1}{1 - \alpha}} \right\}^{\frac{1}{1 - \gamma}}
\]

\[
N_F = \frac{(T - N_I) \gamma (1 - \rho \tau) \theta_I N_I^{\gamma - 1} - \phi (1 - \rho \tau) \theta_I N_I^{\gamma}}{\gamma (1 - \rho \tau) \theta_I N_I^{\gamma - 1} + \phi [((\alpha (1 - \tau_k) + (1 - \alpha)(1 - \tau_n)) \theta_F (\frac{\alpha (1 - \tau) \theta_F}{1/\beta - 1 + \delta})^{\frac{1}{1 - \alpha}} - \delta (\frac{\alpha (1 - \tau_k) \theta_F}{1/\beta - 1 + \delta})^{\frac{1}{1 - \alpha}}]}
\]

\[
K = N_F \left[ \frac{(1 - \tau_k) \theta_f \alpha}{1/\beta - 1 + \delta} \right]^{\frac{1}{1 - \alpha}}
\]

\[
(1 + \tau_c) C = (1 - \tau_k) \alpha Y_F + (1 - \tau_n)(1 - \alpha) Y_F + (1 - \rho \tau) Y_i - \delta K
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R = \tau_c C + \tau_k \alpha Y_f + \tau_n (1 - \alpha) Y_f + \rho \tau Y_i
\]
Equilibrium Results (cont’d)

At the steady state, the closed-form interior solutions are:

\[ N_I = \left\{ \frac{(1 - \rho \tau) \gamma \theta_I}{(1 - \tau_n)(1 - \alpha) \theta_F} \left[ \frac{1}{\gamma (1 - \tau_k \theta_F)} - \delta \right]^{\frac{\gamma - 1}{\gamma - 1 - \alpha}} \right\}^{\frac{1}{1 - \gamma}} \]

\[ N_F = \frac{(T - N_I) \gamma (1 - \rho \tau) \theta_I N_I^{-\gamma - 1} - \phi (1 - \rho \tau) \theta_I N_I^\gamma}{\gamma (1 - \rho \tau) \theta_I N_I^{-\gamma - 1} + \phi [((\alpha(1 - \tau_k) + (1 - \alpha)(1 - \tau_n)) \theta_F (\frac{1 - \tau}{1 / \beta - 1 + \delta})^{1 - \gamma} - \delta (\frac{1 - \tau}{1 / \beta - 1 + \delta})^{1 - \gamma} ]} \]

\[ K = N_F \left[ \frac{(1 - \tau_k \theta_F \alpha}{1 / \beta - 1 + \delta} \right]^{\frac{1}{1 - \alpha}} \]

\[ (1 + \tau_c) C = (1 - \tau_k) \alpha Y_F + (1 - \tau_n)(1 - \alpha) Y_F + (1 - \rho \tau) Y_i - \delta K \]

\[ R = \tau_c C + \tau_k \alpha Y_F + \tau_n (1 - \alpha) Y_F + \rho \tau Y_i \]
Equilibrium Results (cont’d)

- At the steady state, the closed-form interior solutions are:

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N_I = \left\{ \frac{(1 - \rho\tau)\gamma_I}{(1 - \tau_n)(1 - \alpha)\theta_F} \left[ \frac{1}{\alpha(1 - \tau_k)\theta_F} \right]^{\frac{\alpha}{1 - \alpha}} \right\}^{\frac{1}{1 - \gamma}}
\]

\[
N_F = \frac{(T - N_I)\gamma(1 - \rho\tau)\theta_I N_I^{\gamma - 1} - \phi(1 - \rho\tau)\theta_I N_I^\gamma}{\gamma(1 - \rho\tau)\theta_I N_I^{\gamma - 1} + \phi[(\alpha(1 - \tau_k) + (1 - \alpha)(1 - \tau_n))\theta_F(\frac{\alpha(1 - \tau)\theta_F}{1/\beta - 1 + \delta})^{\frac{\alpha}{1 - \alpha}} - \delta(\frac{\alpha(1 - \tau_k)\theta_F}{1/\beta - 1 + \delta})^{\frac{1}{1 - \alpha}}]}
\]

\[
K = N_F \left[ \frac{(1 - \tau_k)\theta_F\alpha}{1/\beta - 1 + \delta} \right]^{\frac{1}{1 - \alpha}}
\]

\[
(1 + \tau_c)C = (1 - \tau_k)\alpha Y_F + (1 - \tau_n)(1 - \alpha)Y_F + (1 - \rho\tau)Y_i - \delta K
\]

\[
R = \tau_c C + \tau_k\alpha Y_F + \tau_n(1 - \alpha)Y_F + \rho\tau Y_i
\]
Marginal Cost of Public Funds

Then, the marginal cost of public funds for three different taxes are defined as follows:

\[
\begin{align*}
MCF_{\tau_k} &= -\frac{\partial U/\partial \tau_k}{\partial R/\partial \tau_k} \\
MCF_{\tau_n} &= -\frac{\partial U/\partial \tau_n}{\partial R/\partial \tau_n} \\
MCF_{\tau_i} &= -\frac{\partial U/\partial \tau_i}{\partial R/\partial \tau_i} \\
MCF_{\tau_c} &= -\frac{\partial U/\partial \tau_c}{\partial R/\partial \tau_c}
\end{align*}
\]
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\[
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\]

\[
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\]
Benchmark Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Source</th>
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<tbody>
<tr>
<td>$\phi$</td>
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<td>$\theta_i$</td>
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<td>Ihrig and Moe (2004, JDE) &amp; $R/Y_f \approx 20%$</td>
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<td>$\alpha$</td>
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</tr>
<tr>
<td>$\beta$</td>
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<td>$\gamma$</td>
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<td>Ihrig and Moe (2004, JDE)</td>
</tr>
<tr>
<td>$\delta$</td>
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<td>RBC Literature</td>
</tr>
<tr>
<td>$T$</td>
<td>1.000</td>
<td>Normalization</td>
</tr>
</tbody>
</table>
MCF of Capital Tax

\[ \tau_n = 25\%, \tau_i = 15\%, \tau_c = 5\%, R/Y_f \approx 20\% \& Y_i/Y_f \approx 10\% \]
MCF of Sales Tax

\[ \tau_n = 20\%, \tau_i = 15\%, \tau_k = 10\%, \frac{R}{Y_f} \approx 20\% \text{ & } \frac{Y_i}{Y_f} \approx 10\% \]
$\tau_i = 15\%, \tau_k = 15\%, \tau_c = 5\%, R/Y_f \approx 20\% \& Y_i/Y_f \approx 10\%$
MCF of Informal Sector Income Tax

\[ \tau_n = 25\%, \tau_k = 10\%, \tau_c = 5\%, \frac{R}{Y_f} \approx 20\% & \frac{Y_i}{Y_f} \approx 10\% \]
Preliminary Findings

• **Capital income tax is the most distortionary one**
  • Limited enforcement and 20%+ rates convexify the MCF by the capital income tax
• Sales tax displays monotone and linear costs, increasing in the rate imposed and decreasing in the enforcement capacity
• Formal wage tax increases steeply beyond 30% with potential non-monotonicities
• Enforcement capacity and tax on the informal sector both reduce MCF
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Future Research

- Document the cost structure for a wide range of parameter space
- Address sources of convexities and non-monotonicities
- Explore alternative methods of taxation and their associated MCFs
  - Uniform income tax, uniform wage tax, ...
- Investigate the implications of alternative functional forms and assumptions for robust conclusions
  - Preferences over labor-leisure, labor-consumption, ...
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Thank you!