MEASURING THE DEADWEIGHT LOSS FROM TAXATION IN A SMALL OPEN ECONOMY

A general method with an application to Sweden

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MOTIVATION

• The optimal tax structure minimizes the total deadweight loss from raising the necessary revenue and attaining the desired amount of redistribution

• To solve the optimal tax problem, we need estimates of the marginal deadweight loss from the different tax instruments

• This paper offers a general equilibrium method of estimating marginal deadweight losses in a small open economy
The general equilibrium approach to the measurement of deadweight loss

The theoretical general equilibrium framework of the present paper

General formulae for the marginal deadweight loss from the different tax instruments

Calibration methods

Application: The marginal deadweight loss from taxation in Sweden
Harberger (1964): The total deadweight loss from imposing a (unit) tax on good $k$ is

$$DWL_k = \underbrace{-\frac{1}{2} \tau_k^2 \frac{dX_k}{d\tau_k}}_{\text{Harberger triangle}} \quad \underbrace{- \sum_{i \neq k} \tau_i \tau_k \frac{dX_i}{d\tau_k}}_{\text{Tax interaction effects}}$$

$\tau_j = \text{unit tax rate on good } j$

$X_j = \text{(compensated) demand for good } j$
MEASURING DEADWEIGHT LOSS: ALTERNATIVE APPROACHES

- Ignore tax interaction effects (Problem: potentially large bias)

- Use large scale CGE models to capture general equilibrium effects (Problem: large models tend to become “black boxes”)

- Goulder and Williams (JPE, 2003): Use analytical model that accounts for interaction between commodity markets and the labour market (Problems: Interactions with tax bases for capital income ignored and the DWL from capital taxes cannot be analysed)
APPROACH IN THE PRESENT PAPER

- Simple transparent GE framework accounting for the interaction between all the major tax bases

- Allows decomposition of the marginal deadweight loss into the losses stemming from adjustment of the various tax bases

- New calibration method accounts for cross-restrictions on key elasticities

- Open economy framework allows for the shifting of source-based capital taxes
THEORETICAL FRAMEWORK

• Two-period life cycle model

• Capital perfectly mobile; labour immobile (or imperfectly mobile)

Tax instruments:

• Labour income tax

• Consumption tax

• Residence-based capital income tax on saving

• Source-based business income tax on investment
\[
U = U(C_1, C_2, L)
\]

\[
PC_1 = WL - T - PS, \quad PC_2 = \left[1 + r \left(1 - t^r \right) \right] PS + B_2
\]

\[
T = t^W WL - B_1, \quad 0 < t^W < 1, \quad B_1 > 0
\]

Utility maximization yields the expenditure function

\[
E = E \left( P, \frac{1}{1 + r \left(1 - t^r \right)}, W \left(1 - t^w \right), \bar{U} \right)
\]

where \(P\) includes indirect taxes
FIRMS

\[ Y = F(K, L), \quad \Pi = Y - \rho K - WL, \quad \rho \equiv r + \delta + t^k \]

Profit maximization implies:
\[ F_K(K, L) = \rho, \quad F_L(K, L) = W \]

\[
\frac{dL}{L} = -\varphi \varepsilon_w^L \cdot \left( \frac{dt^k}{\rho} \right), \quad \frac{dK}{K} = -\left( \varepsilon^K_{\rho} + \varphi \varepsilon_w^L \right) \cdot \left( \frac{dt^k}{\rho} \right),
\]

\[ \varepsilon_w^L \equiv \text{wage elasticity of labour supply} \]
\[ \varepsilon^K_{\rho} \equiv \text{user cost elasticity of capital demand} \]
\[ \varphi \equiv \frac{\rho K}{WL} \quad \text{(business profits relative to labour income)} \]
Present value of net taxes paid by a cohort:

\[
R = \left[ t^w + t^c \left( 1 - t^w \right) \right] WL - \left( 1 - t^c \right) \left( B_1 + \frac{B_2}{1 + r \left( 1 - t^r \right)} \right) \\
+ t^k K + \frac{t^r rPS - B_2}{1 + r \left( 1 - t^r \right)}
\]

\[ t^c = \text{consumption tax rate as a fraction of consumer price} \]
The Marginal Deadweight Loss from Taxation

\[ E = \text{expenditure function} \]

Marginal deadweight loss:

\[ \frac{dDWL}{dt^i} = \frac{dE}{dt^i} - \frac{dR}{dt^i} = \frac{dE}{dt^i} - \frac{dR^s}{dt^i} - \frac{dR^d}{dt^i} , \quad i = c, k, r, w \]

Note: In general we have \( \frac{dE}{dt^i} = \frac{dR^s}{dt^i} \) \( \Rightarrow \)

\[ \frac{dDWL}{dt^i} = -\frac{dR^d}{dt^i} \]
THE DEGREE OF SELF-FINANCING

\[ DSF = \text{the fraction of the initial revenue gain which is lost due to behavioural responses} \]

\[ DSF_{t_i} \equiv -\frac{dR^d / dt^i}{dR^s / dt^i} = \frac{dDWL / dt^i}{dR^s / dt^i} \]
THE MARGINAL DEADWEIGHT LOSS FROM THE LABOUR INCOME TAX

\[
DSF_{t^w} = \frac{t^w \varepsilon^L_w}{1 - t^w} + \frac{t^c (1 - t^w) \varepsilon^L_w}{1 - t^w} + \frac{m^k \theta^k \varepsilon^L_w}{1 - t^w} + \frac{t^r \theta^s \varepsilon^S_w}{1 - t^w}
\]

\[
\varepsilon^L_w \equiv \text{compensated net wage elasticity of labour supply}
\]
\[
\varepsilon^S_w \equiv \text{compensated net wage elasticity of saving}
\]
\[
m^k \equiv \frac{t^k}{\rho - \delta} = \text{marginal effective tax rate on business income}
\]
\[
\theta^k \equiv \frac{(\rho - \delta) K}{WL}, \quad \theta^s \equiv \frac{rPS / WL}{1 + r(1 - t^r)}
\]
THE MARGINAL DEADWEIGHT LOSS FROM THE GENERAL CONSUMPTION TAX

\[ DSF_{tc} = \left( \frac{1 - t^w}{1 - t^w + b_1 + pb_2} \right) \frac{dDWL / dt^w}{dR^s / dt^w} \]

\[ b_1 \equiv \frac{B_1}{WL}, \quad b_2 \equiv \frac{B_2}{WL}, \quad p \equiv \frac{1}{1 + r \left( 1 - t^r \right)} \]
THE MARGINAL DEADWEIGHT LOSS FROM THE BUSINESS INCOME TAX

\[
DSF^k_t = \left( \frac{tw \varepsilon_w^L}{1 - tw} \right) + \left( t^c \left( 1 - tw \right) \varepsilon_w^L \right) + \left( \frac{m^k \left( \varepsilon^K \left( \frac{\rho - \delta}{\rho} \right) + \theta^k \varepsilon_w^L \right)}{1 - tw} \right) + \frac{t^r \theta^s \varepsilon_w^S}{1 - tw}
\]

\[
= \frac{m^k \left( \frac{\rho - \delta}{\rho} \right) \varepsilon^K}{1 - tw} + \frac{dDWL / dt^w}{dR^s / dt^w}
\]
THE MARGINAL DEADWEIGHT LOSS FROM THE SAVINGS INCOME TAX

\[ DSF_{t^r} = \left( \frac{t^w \varepsilon^L_r}{1-t^r} \theta^s \right) + \left( \frac{t^c \left(1-t^w\right) \varepsilon^L_r}{1-t^r} \theta^s \right) + \left( \frac{m^k \theta^k \varepsilon^L_r}{1-t^r} \theta^s \right) + \left( \frac{t^r \varepsilon^S_r}{1-t^r} \right) \]

\[ \varepsilon^L_r \equiv \text{compensated net interest elasticity of labour supply} \]

\[ \varepsilon^S_r \equiv \text{compensated net interest elasticity of saving} \]

\[ \theta^s \equiv \frac{prPS}{WL} = \text{present value of capital income} \]

\[ \theta^s \equiv \frac{prPS}{WL} = \text{present value of labour income} \]
Using the Slutsky equations and the budget constraints, we derive the links between factor supply elasticities implied by the life cycle model. For example:

\[
\varepsilon_w^S = \left( \frac{1-t^w}{1-t^w + b_1 - \left( \frac{b_2}{1+g^c} \right)} \right) \varepsilon_w^L, \quad g^c \equiv \frac{C_2}{C_1} - 1
\]

\[
\varepsilon_r^L = \left( \frac{r\left(1-t^r\right)}{1+r\left(1-t^r\right)} \right) \left(1-c\right) \varepsilon_w^L, \quad c \equiv \frac{1}{1+p\left(1+g^c\right)}
\]

We also derive the link between the compensated and the uncompensated interest elasticities of saving. The parameter \( \theta^s \) is calibrated from a multi-period theoretical life cycle model.
CALIBRATION METHODS: EFFECTIVE TAX RATES

• The effective overall tax rate on consumption is estimated from VAT and excise tax rates, using disaggregated consumption data and assuming consumers optimise the allocation of consumption.

• The effective overall tax rate on saving is estimated from tax rates on different forms of saving, assuming consumers optimise their portfolio composition.

• The effective marginal tax rate on business income is estimated by the King-Fullerton method as a weighted average of the tax rates on debt-financed and equity-financed investment.

• The effective marginal tax rate on labour income includes social security taxes and is a weighted average across income groups.
### Elasticities of factor supply and demand

- $\varepsilon_w^L = 0.264$
- $\varepsilon_r^L = 0.055$
- $\hat{\varepsilon}_r^S = 0.0$
- $\varepsilon_r^S = 0.559$
- $\varepsilon_w^S = 0.201$
- $\varepsilon_K = 1.0$

### Elasticities of substitution

- $1/ \gamma = 1$
- $\phi = 1.0$
- $\sigma = 1.0$
- $\sigma_h = 1.5$
- $\sigma_o = 1.0$

### Initial effective tax and transfer rates

- $t^w = 0.476$
- $t^c = 0.249$
- $t^r = 0.315$
- $m^k = 0.079$
- $b_1 = 0.227$
- $b_2 = 0.086$

### Income and consumption shares etc.

- $\Theta^s = 0.145$
- $\Theta^k = 0.15$
- $P_HC_H/PC = 0.2$
- $S^F/S^l = 0.931$

### Other parameters (annual basis)

- $r = 0.05$
- $\pi = 0.02$
- $g^w = 0.02$
- $g^c = 0.01$
- $\delta = 0.09$
- $T = 60$
- $n = 45$
## DEGREES OF SELF-FINANCING: BASELINE SCENARIOS

<table>
<thead>
<tr>
<th>Cut in effective marginal tax rate on</th>
<th>Contribution to DSF from higher revenue from taxes on</th>
<th>Total DSF</th>
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<tbody>
<tr>
<td></td>
<td>Labour income</td>
<td>Consumption income</td>
</tr>
<tr>
<td>Labour income</td>
<td>23.9</td>
<td>6.6</td>
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<tr>
<td>Consumption</td>
<td>16.0</td>
<td>4.4</td>
</tr>
<tr>
<td>Business income</td>
<td>23.9</td>
<td>6.6</td>
</tr>
<tr>
<td>Savings income</td>
<td>26.5</td>
<td>7.3</td>
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</table>
### SENSITIVITY ANALYSIS:
TOTAL DEGREES OF SELF-FINANCING (%)

<table>
<thead>
<tr>
<th>Change in effective marginal tax rate on</th>
<th>Base line(^1)</th>
<th>(1 / \eta = 0.2)</th>
<th>(1 / \eta = 0.5)</th>
<th>(\hat{\varepsilon}_r^s = -0.3)</th>
<th>(\hat{\varepsilon}_r^s = 0.3)</th>
<th>(g_c^c = 0.005)</th>
<th>(g_c^c = 0.015)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>((\varepsilon_w^L = 0.17))</td>
<td>((\varepsilon_w^L = 0.36))</td>
<td>((\varepsilon_r^S = 0.26))</td>
<td>((\varepsilon_r^S = 0.86))</td>
<td>((\theta^s = 0.098))</td>
<td>((\theta^s = 0.191))</td>
<td></td>
</tr>
<tr>
<td>Labour income</td>
<td>33</td>
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<td>45</td>
<td>33</td>
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<tr>
<td>Consumption</td>
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<td>39</td>
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<tr>
<td>Savings income</td>
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<td>47</td>
<td>73</td>
<td>46</td>
<td>74</td>
<td>73</td>
<td>53</td>
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CONCLUSIONS

• In a high-tax country like Sweden, the deadweight loss from an across-the-board increase in the marginal labour income tax rate could be around 1/3, and the deadweight loss from an increase in the marginal savings tax rate could be more than ½

• Robust result: DWL(investment tax on normal return) > DWL(labour tax) > DWL(consumption tax): Case for an ACE

• Ignoring tax interaction effects when analysing the deadweight loss from direct and indirect taxes on labour does not lead to major errors, but ignoring such effects when analysing taxes on capital leads to serious underestimation of the DWL

• The DWL from the savings income tax appears to be quite high, so there may be a good case for the Nordic dual income tax with a low capital income tax rate