Optimal Income Taxation with Unemployment and Wage Responses: A Sufficient Statistics Approach

Kavan KUCKO
Boston University

Kory KROFT
University of Toronto and NBER

Etienne LEHMANN
CRED (TEPP) University Panthéon-Assas Paris II

Johannes SCHMIEDER
Boston University, NBER and IZA

Motivation of the paper

- Many countries shift the income support policies from welfare to in-work benefits: EITC in the US, WFTC in UK, WITB in Canada, PPE/RSA/prime d'activité in France,...
- Are these *making work pay* policies still desirable if the unemployed workers cannot find a job?
- How unemployment and wage responses modify the optimal redistributive policy and in particular the trade off of Saez (2002) between helping the non-employed versus the working poor?
- We want to address these issues without imposing too strong assumptions on how the labor market works.

⇒ We adopt a sufficient statistics approach.

Main Results

- We derive a general optimal tax formula that nests many micro founded models of the labor market.
- We identify 3 sufficient statistics to be estimated: the *macroeconomic/general equilibrium* employment responses, the macroeconomic participation responses, the *microeconomic participation* responses.
    - When unemployment is exogenous, only the microeconomic employment responses need to be estimated.
    - We relate the macro-micro participation gap in a Diamond Mortensen Pissarides model with proportional bargaining to the deviation of the bargaining power from the Hosios (1990) condition.
- We show how to estimate these sufficient statistics using US data.
- Provisional empirical results: macro participation $<$ micro participation, making EITC less desirable than in Saez (2002).

Related Literatures

- Optimal taxation with employment responses: Diamond (1980), Saez (2002), Choné and Laroque (2005, 2011), Hungerbühler et al. (2006),...
- The sufficient statistics approach on optimal taxation: Harberger, Baily (1978), Feldstein (1999) Saez (2002), Chetty (2008, 2009), Landais Michaillat Saez (2015),...
- Estimating the effects of EITC: Eissa and Liebman (1996), Meyer and Rosenbaum (2001), Eissa and Hoynes (2008), Azmat (2008), Leigh (2010), Rothstein (2010),...
- Micro versus macro elasticities: Chetty (2012), Keane and Rogerson (2012), Chetty, Guren, Manoli and Weber (2013), Crepon et al. (2013), Jäntti, Pirttilä and Selin (2015), Lalive Landais and Zweimuller (2015).

The general model

- An extension of the optimal tax model of Saez (QJE 2002) with a finite number of income levels indexed $i \in \{0, 1, ..., I\}$.
- Occupation $i \in \{1, ..., I\}$ corresponds to a specific labor market where the gross wage is w_i and the net wage is $c_i = w_i - T_i$.
- Occupation 0 corresponds to non-employment where $b = c_0 = -T_0$.
- On labor market i, only a fraction $p_i \in (0, 1]$ of the k_i participants is employed. The unemployment rate is $1 - p_i$ and the number of employed is $h_i = p_i \ k_i$.
- Among the h_0 non-employed, there are k_0 non-participants and $\sum_{i=1}^{I}(1-p_i)k_i$ unemployed.

Timing of the model

1. The government chooses policy $\mathbf{t} \overset{\text{def}}{\equiv} (T_1, ..., T_I, b)$.
2. Each individual chooses an occupation $i \in \{0, 1, ..., I\}$.
3. On each labor market $i \in \{1, ..., I\}$, only a fraction $p_i \in (0, 1]$ of the k_i participants are employed. The number of employed is $h_i = p_i \; k_i$.

- We are agnostic about macroeconomic (general equilibrium) responses to taxation, which are described by smooth reduced-forms:
  - For gross wages: $w_i = \mathscr{W}_i(T_1, ..., T_I, b)$ with $b < w_1, ... < w_I$
  - For net wages: $c_i = \mathscr{C}_i(T_1, ..., T_I, b) \overset{\text{def}}{\equiv} \mathscr{W}_i(T_1, ..., T_I, b) - T_i$.
  - For unemployment: $p_i = \mathscr{P}_i(T_1, ..., T_I, b)$ with $\mathscr{P}_i(\cdot) \in (0, 1]$.
- We define microeconomic (partial equilibrium) responses to taxation as those occurring for fixed w_i and p_i (i.e. the relevant ones when e.g. control and treatment groups face the same job opportunities).

Labor supply

- Individual m gets utility:
  - $u(c_i) - d_i - \chi_i(m)$ if employed in occupation i,
  - $u(b) - \chi_i(m)$ if unemployed in labor market i,
  - $u(b)$ if staying out of the labor force.

  where $(\chi_1(m), ..., \chi_I(m))$ are smoothly distributed and $\chi_0(m) \equiv 0$.
- Let $U_i \stackrel{\text{def}}{\equiv} p_i \left(u\left(c_i\right) - d_i\right) + \left(1 - p_i\right) u(b)$ denote the gross utility expected by participating in occupation i and $U_0 \stackrel{\text{def}}{\equiv} u(b)$.
- Individual m chooses to participate where $U_i - \chi_i(m)$ is the highest.

$\Rightarrow$ Participation decisions depend only on expected utility $U_1, ..., U_I, u(b)$ through $k_i = \hat{\mathcal{K}}_i(U_1, ..., U_I, u(b))$.

Labor market outcomes

- Expected utility is given by:

$$\mathscr{U}_i(\mathbf{t}) \stackrel{\text{def}}{\equiv} \mathscr{P}_i(\mathbf{t}) \left(u\left(\mathscr{C}_i(\mathbf{t})\right) - d_i\right) + \left(1 - \mathscr{P}_i(\mathbf{t})\right) u(b)$$

with:

$$\frac{\partial \mathscr{U}_i}{\partial T_j} = \underbrace{\left[\frac{\partial \mathscr{C}_i}{\partial T_j} + \frac{\partial \mathscr{P}_i}{\partial T_j} \frac{u(c_i) - d_i - u(b)}{p_i \; u'(c_i)}\right]}_{-\mathbb{1}_{i=j} \text{ for microeconomic responses}} p_i \, u'(c_i)$$

- Participation decisions are given by:

$$k_i = \mathcal{K}_i(\mathbf{t}) \stackrel{\text{def}}{\equiv} \hat{\mathcal{K}}_i\left(\mathscr{U}_1(\mathbf{t}), ..., \mathscr{U}_i(\mathbf{t}), u(b)\right)$$

- Employment is given by: $h_i = \mathcal{H}_i(\mathbf{t}) \stackrel{\text{def}}{\equiv} \mathscr{P}_i(\mathbf{t}) \, \mathcal{K}_i(\mathbf{t})$.

Government

- We assume the government's objective depends only on expected utility (Type-dependent weighted utilitarianism):

$$SWF = \int_m \gamma(m) \left(\max_i \quad \mathscr{U}_i(\mathbf{t}) - \chi_i(m) \right) d\mu(m)$$

- Social weights: $g_i = \dfrac{p_i\, u'(c_i)\, \int_{m \in M_i} \gamma(m)\, d\mu(m)}{\lambda\, h_i}$ captures the microeconomic effect of a tax cut on the SWF, in monetary terms.
- The budget constraint is:

$$\sum_{i=1}^{I} T_i\, h_i = b\, h_0 \qquad \Leftrightarrow \qquad \sum_{i=1}^{I} \underbrace{(T_i + b)}_{\text{Employment tax}} \quad h_i = b$$

Optimal policy

The government solves:

$$\int_m \gamma(m) \left(\max_i \quad \mathscr{U}_i(\mathbf{t}) - \chi_i(m) \right) d\mu(m) \quad s.t. : \sum_{i=1}^{I} (T_i + b) \, \mathcal{H}_i(\mathbf{t}) = b$$

The first-order condition w.r.t T_j is:

$$0 \;=\; \underbrace{h_j}_{\text{Mechanical effect}} + \underbrace{\sum_{i=1}^{I} (T_i + b) \, \frac{\partial \mathcal{H}_i}{\partial T_j}}_{\text{Behavioral effects}}$$

$$+ \underbrace{\sum_{i=1}^{I} \left[\frac{\partial \mathscr{C}_i}{\partial T_j} + \frac{\partial \mathscr{P}_i}{\partial T_j} \frac{u(c_i) - d_i - u(b)}{p_i \; u'(c_i)} \right] g_i h_i}_{\text{Social Wefare effects}}$$

What's new with unemployment?

- The behavioral effects depend on macroeconomic employment responses and not only on microeconomic labor supply ones.
- The Social Welfare effects can be decomposed in three parts
  - The direct effects are the same.
  - Changes in participation decisions induce only second-order effects on the social objective because of the envelope argument of Saez (2001,2002).
  - Changes in wages and in conditional employment probabilities induce first-order effects on the social objective because they are general equilibrium (macro) responses induced by the market instead of being directly triggered by individual choices.

  ⇒ b/c of wage and conditional employment responses, the SW effects differ at the micro and at the macro level, the corrective terms being:

$$\frac{\partial \mathscr{C}_i}{\partial T_j} + \frac{\partial \mathscr{P}_i}{\partial T_j} \frac{u(c_i) - d_i - u(b)}{p_i \; u'(c_i)}$$

The sufficient statistic approach

- It may be hard in practice to estimate macroeconomic wage responses.
- To see why corrective "blue terms" can be re-expressed in terms of macro versus micro participation responses, consider the no-cross-effect case where $\frac{\partial \mathscr{W}_i}{\partial T_j} = \frac{\partial \mathscr{P}_i}{\partial T_j} = \frac{\partial \hat{\mathcal{K}}_i}{\partial U_j} = 0$ when $j \neq i$.
- The optimal tax formula then simplifies to:

$$0 = h_j + (T_j + b)\ \frac{\partial \mathcal{H}_j}{\partial T_j} + \left[\frac{\partial \mathscr{C}_j}{\partial T_j} + \frac{\partial \mathscr{P}_j}{\partial T_j}\frac{u(c_j) - d_j - u(b)}{p_j u'(c_j)}\right] g_j h_j$$

while macro and micro participation responses are related through:

$$\frac{\partial \mathcal{K}_j}{\partial T_j} = \left[\frac{\partial \mathscr{C}_j}{\partial T_j} + \frac{\partial \mathscr{P}_j}{\partial T_j}\frac{u(c_j) - d_j - u(b)}{p_j u'(c_j)}\right]\ \frac{\partial \mathcal{K}_j}{\partial T_j}\bigg|^{\text{Micro}}$$

- The corrective term may be larger or lower than -1 when $\frac{\partial \mathscr{P}_j}{\partial T_j} = \frac{\partial \mathscr{P}_j}{\partial w_j} \times \frac{\partial \mathscr{W}_j}{\partial T_j}$, depending on $\frac{\partial \mathscr{P}_j}{\partial w_j}$.

Optimal policy in the no-cross effect case

Let η_j denote the macro employment elasticity, π_j denote the macro participation elasticity and π_j^{Micro} denote the micro participation elasticity.

Proposition 1 (optimal tax formula in the no-cross effects case)

$$\frac{T_j + b}{c_j - b} = \frac{1 - \frac{\pi_j}{\pi_j^{Micro}} g_j}{\eta_j}$$

Corollary 1

In the no cross effect case, the optimal employment tax is negative whenever $g_1 > \frac{\pi_1^{Micro}}{\pi_1}$.

Optimal policy in matrix form

- Let $\mathcal{A}$ be the matrix of corrective terms $\frac{\partial \mathscr{C}_i}{\partial T_j} + \frac{1}{p_i} \frac{\partial \mathscr{P}_i}{\partial T_j} \frac{u(c_i) - d_i - u(b)}{u'(c_i)}$.
- $\mathcal{A}$ translates macroeconomic responses into microeconomic ones:

$$\frac{\mathbf{d}\mathscr{U}}{\mathbf{dT}} = -\mathcal{A} \cdot \left.\frac{\mathbf{d}\mathscr{U}}{\mathbf{dT}}\right|^{\text{Micro}} \qquad \text{and :} \qquad \frac{\mathbf{d}\mathcal{K}}{\mathbf{dT}} = -\mathcal{A} \cdot \left.\frac{\mathbf{d}\mathcal{K}}{\mathbf{dT}}\right|^{\text{Micro}}$$

Proposition 2

$$\mathbf{0} = \mathbf{h} + \frac{\mathbf{d}\mathcal{H}}{\mathbf{dT}} \cdot (\mathbf{T} + \mathbf{b}) - \frac{\mathbf{d}\mathcal{K}}{\mathbf{dT}} \cdot \left(\left.\frac{\mathbf{d}\mathcal{K}}{\mathbf{dT}}\right|^{Micro} \right)^{-1} \cdot (\mathbf{g}\ \mathbf{h})$$

- The SWF and participation decisions are functions of $(U_1, ..., U_I, u(b))$.
- The same correction applies to compute macroeconomic participation responses and social welfare effects from microeconomic ones.

$\Rightarrow$ The sufficient stats to be estimated are $\frac{\partial \mathcal{H}_i}{\partial T_j}$, $\frac{\partial \mathcal{K}_i}{\partial T_j}$ and $\left.\frac{\partial \mathcal{K}_i}{\partial T_j}\right|^{\text{Micro}}$

A DMP matching economy with proportional bargaining

- This economy assumes constant productivity y_i, job creating cost $\kappa_i \in (0, y_i)$ and CRS matching functions with elasticity $\mu_i \in (0,1)$.
- Matching frictions leads to a labor demand where p does not depend on labor supply, so employment increases with the labor supply:

$$p_i = P_i\left(Q_i^{-1}\left(\frac{\kappa_i}{y_i - w_i}\right)\right)$$

- The proportional bargaining assumption:

$$w_i = \mathscr{W}_i(T_i, b) \equiv \beta_i \, y_i + (1-\beta_i)(T_i + d_i + b)$$

Proposition 3 (The ratio of macro over micro responses vs Hosios)

$$\frac{\partial \mathscr{U}_i}{\partial T_i} = \frac{\beta_i}{\mu_i} \frac{\partial \mathscr{U}_i}{\partial T_i}\bigg|^{Micro} \qquad \Rightarrow \qquad \frac{T_i + b}{c_i - b} = \frac{1 - \frac{\beta_i}{\mu_i} g_i}{\eta_i}$$

The Job-rationing paradigm

- The job rationing paradigm assumes search frictions away but assume decreasing marginal productivity.
- Under a fixed gross wage
  - A tax cut does not change employment $\frac{\partial \mathcal{H}}{\partial T} = 0$.
  - A tax cut increases participation at the micro level $\frac{\partial \mathcal{K}}{\partial T}\Big|^{\text{Micro}} > 0$
  - A tax cut reduces the probability to find a job $p = h/k$ for participants

  $\Rightarrow$ The macro participation response is lower than the micro one $\frac{\partial \mathcal{K}}{\partial T}\Big|^{\text{Micro}} > \frac{\partial \mathcal{K}}{\partial T}$.
- Different version of job-rationing models depending on the wage setting (efficiency wages, wage bargaining, ...) and job rationing (Lee and Saez (2012)).
- Michaillat (2012) and Landais Michaillat and Saez (2015) mix the job-rationing and the DMP paradigms.

Marginal tax rates effects on wage bargaining

- For a given tax liability, a higher marginal tax rate induces the "wage setter" to substitute lower gross wage (i.e. higher employment or profits) for lower net wage (workers' disposable income) (Hersoug (1984) in a monopoly union model, Lockwood and Manning (1993) in a union right-to manage model, Pissarides (1985, 1998, 2000) in a matching model with individual Nash bargaining, Piketty Saez Stantcheva (2014) in a top 1% optimal income tax model).

⇒ Matrix $\frac{\mathbf{d}\mathscr{W}}{\mathbf{dT}}$ and therefore the matrices $\frac{\mathbf{d}\mathscr{P}}{\mathbf{dT}}$, $\frac{\mathbf{d}\mathscr{U}}{\mathbf{dT}}$, $\frac{\mathbf{d}\mathcal{K}}{\mathbf{dT}}$ and $\frac{\mathbf{d}\mathcal{H}}{\mathbf{dT}}$ are non-diagonal.

- As $\frac{\partial \mathscr{W}_i}{\partial T_i - T_{i-1}} < 0$, so $\frac{\partial \mathscr{P}_i}{\partial T_i - T_{i-1}} > 0$, increasing tax progressivity is *ceteris paribus* beneficial for tax revenues (Hungerbühler et al. (2006), Lehmann et al. (2011)).

Data

- We use CPS march supplement and ORG
- 1984 - 2011.
- Single women, aged 18-55, not in military service or full-time school
- For T_i, we use a tax simulator NBER TAXSIM to compute federal taxes, states taxes, Fica, EITC
- For b, we use developed calculator using AFDC/TANF and food stamp data from Urban Institute. We estimate take-up rates for each program using SIPP.

Empirical strategy

- Define local labor market by cells made of education, state and year.
- Let m = individual, s = state, t = year-month, n = number of kids, e = education group.

$$\begin{aligned} y_{s,t,n,m} &= \beta^{Micro}\overline{T}_{s,t,e,n} + \Gamma\ X_{s,t,n,m} + \delta_{s,t} + \gamma_n + \alpha_e + u_{s,t,n,m} \\ \overline{y}_{s,t} &= \beta^{Macro}\overline{T}_{s,t,e} + \Gamma\ \overline{X}_{s,t} + \delta_s + \gamma_t + \alpha_e + u_{s,t,e} \end{aligned}$$

- Variations across *Time* × *State* identify macroeconomic responses.
- Variations across *Time* × *State* × *#Kids* identify microeconomic ones.
- Identifying assumption: β^{Micro} and β^{Macro} do not vary across cells.

Inputing Tax liabilities

- We observe earnings neither for non-participants nor for unemployed, so we do not observe their would be tax liability if they were employed.
- Following Eissa and Hoynes (2004, JPubE) and Gelber and Mitchell (2012, REStud), we use imputed earnings for both employed and non employed.
- We estimate predicted log earnings using the subsample of employed individuals and one Mincer estimation per year and education group.
- We then use this predicted earnings to impute tax liabilities (micro) and mean tax liabilities in education, year time cells (macro).

A simulated instrumental approach

- Imputed tax liabilities are endogenous due changes in demographics or income distribution.
- Following Currie and Gruber (1996), Auten and Caroll (1999) or Gruber and Saez (2002), we instrument imputed tax liabilities by changes in inputed tax liability holding fixed income and demographic distributions, using a fixed national sample of imputed earnings weights.
- For micro tax liability, instruments are cell means where cells are defined by education, year, state and number of children.
- For macro tax liability, cell means are defined by education, year and state.

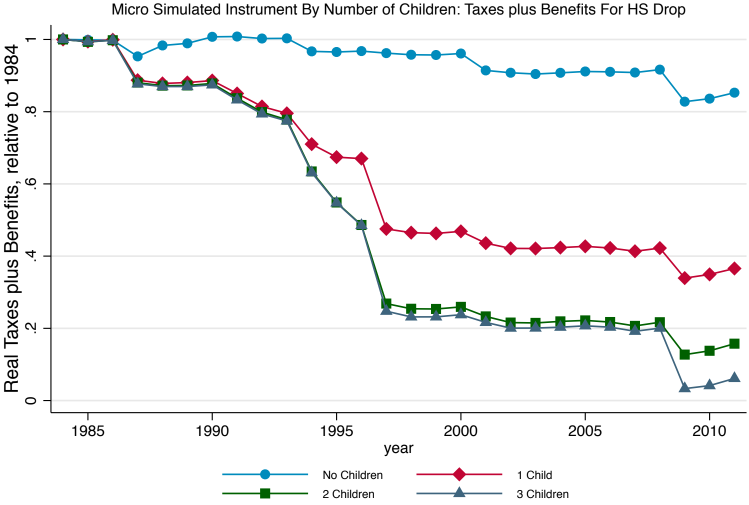

Figure 1: Micro Variations in Taxes plus Benefits

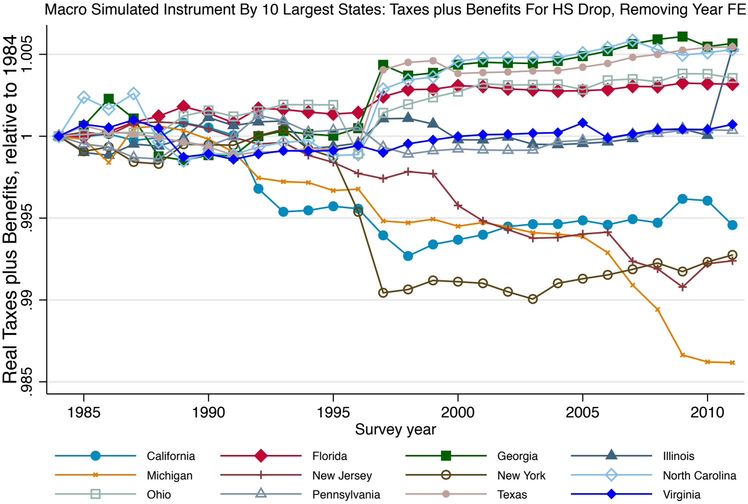

Figure 2: Macro Variations in Taxes plus Benefits

LHS Variable	Participation: $\mathcal{K}_i$	Employment: $\mathcal{H}_i$
Micro responses:	-0.034	-0.033
$\frac{\partial}{\partial T_i}\Big\vert^{Micro}$	[0.002]***	[0.002]***
Num. Obs	773367	773367
Mean of Dep. Var.	0.77	0.70
$\overline{T+b}$	14259.0	14259.0
Tax Elasticity	-0.63	-0.66
Macro responses:	-0.030	-0.027
$\frac{\partial}{\partial T_i}$	[0.017]*	[0.018]
Num. Obs	4284	4284
Mean of Dep. Var.	0.74	0.67
$\overline{T+b}$	12479.3	12479.3
Tax Elasticity	-0.51	-0.51

Table 1: Micro and Macro Responses

Micro Participation Tax Liability x	Marginal Effect	Interaction term	Weak Labor M.	Strong Labor M.
6-mo change in unemp	-0.034	0.0011	-0.033	-0.036
	(0.002)	(0.0004)		
State unemp. rate	-0.035	0.0012	-0.030	-0.039
	(0.002)	(0.0003)		
Unemp above 9 pct	-0.035	0.0053	-0.029	-0.035
	(0.002)	(0.0013)		
Macro Participation				
6-mo change in unemp	-0.029	0.0043	-0.024	-0.035
	(0.017)	(0.0030)		
State unemp. rate	-0.034	0.0011	-0.029	-0.039
	(0.018)	(0.0012)		
Unemp above 9 pct	-0.031	0.0089	-0.022	-0.031
	(0.017)	(0.0052)		

Table 2: Participation Responses and Labor market conditions

Micro Employment Tax Liability x	Marginal Effect	Interaction term	Weak Labor M.	Strong Labor M.
6-mo change in unemp	-0.033	0.0007	-0.032	-0.034
	(0.002)	(0.0005)		
State unemp. rate	-0.033	0.0015	-0.028	-0.039
	(0.002)	(0.0003)		
Unemp above 9 pct	-0.033	0.0074	-0.026	-0.033
	(0.002)	(0.0018)		
Macro Employment				
6-mo change in unemp	-0.027	0.0030	-0.023	-0.030
	(0.018)	(0.0031)		
State unemp. rate	-0.035	0.0018	-0.027	-0.042
	(0.019)	(0.0013)		
Unemp above 9 pct	-0.029	0.0112	-0.017	-0.029
	(0.017)	(0.0060)		

Table 3: Employment Responses and Labor market conditions

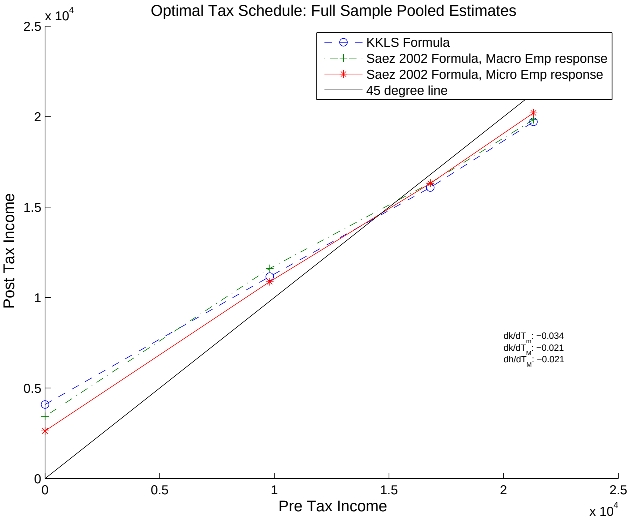

Figure 3: Optimal Tax and Transfer Schedule Comparing KKLS Formula with Saez (2002) Formula

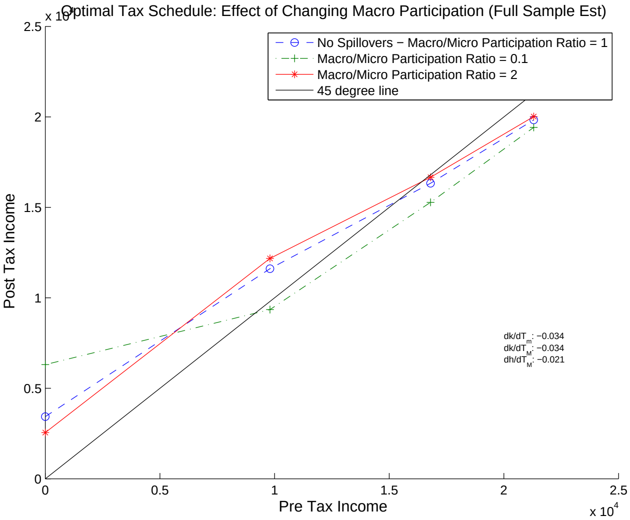

Figure 4: Optimal Tax and Transfer Schedule: Comparative Statics with Varying the ratio of Macro over Micro Participation Response

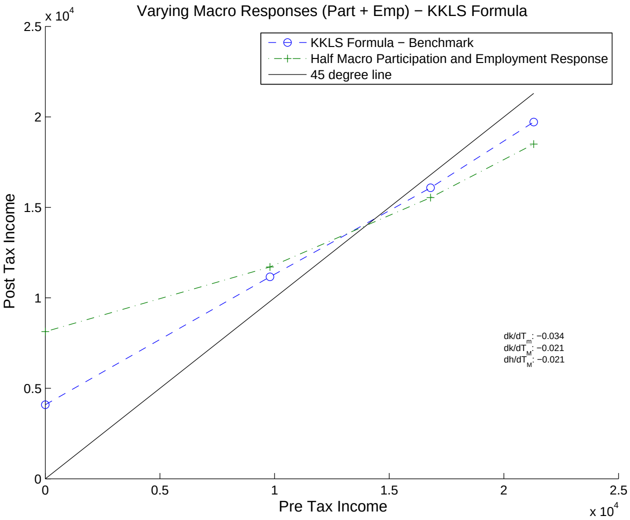

Figure 5: Optimal Tax and Transfer Schedule: Comparative Statics with Varying Macro Participation and Employment Responses

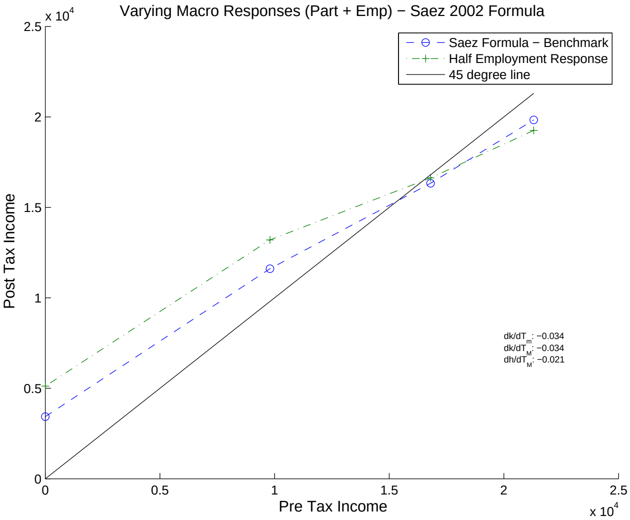

Figure 6: Optimal Tax and Transfer Schedule: Comparative Statics with Varying Macro Participation and Employment Responses

To conclude

- Sufficient stat formula are affected by the existence of unemployment
- Behavioral effects depend on macro employment and not on micro labor supply responses.
- Social welfare effects needs to encapsulate wage and unemployment responses.
- The (matrix) ratio of macro over micro participation responses correspond to this corrective term.
- In the no-cross effect case, EITC is desirable iff social weight on working poor is higher than micro over macro participation elasticity.
- Macro participation $<$ micro participation making EITC less likely than previously thought.