Generalized Compensation Principle

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Introduction

- Economic disruption affects wage distribution $\rightsquigarrow$ winners and losers
  - e.g., technological change, immigration inflow, trade liberalization
- Welfare compensation problem: can we design a reform of the tax system that offsets the losses by redistributing the winners' gains?
  - ... and if so, is it budget-feasible?
- Traditional PF [Kaldor 1939, Hicks 1939/40]: compensating variation
  - amount that agent i is willing to pay to be as well off as before the shocks
  - limitation 1: only distortionary income taxes are available policy tools
  - limitation 2: many disruptions of interest require general equilib. setting

Introduction

- E.g., consider an immigration inflow $\rightsquigarrow$ no welfare impact in PE
  - in GE, higher supply of labor affects wage distribution via two channels:
  - (i) decreasing marginal product, (ii) skill complementarities in production
- Combining distortionary taxes and GE makes the compensation difficult
  - lowering taxes raises labor supply – just like the immigration inflow . . .
  - further welfare effects that need to be compensated using the tax code

$\rightsquigarrow$ complex fixed point problem

- **Goal:** design tax reform to bring each agent's utility back to initial level
  - consider (marginal) disruption of wage distribution in arbitrary direction
  - **result:** compensating reform and fiscal surplus in closed-form
  - **application:** compensating the impact of automation (robots) in the US

Introduction

- **First step:** partial equilibrium environment with distortionary taxes
  - key: to a first order, indirect utility moves one-for-one with total tax bill
  - because envelope theorem $\rightsquigarrow$ marginal tax rate does not affect welfare
  - adjust average tax rate to cancel out the exogenous wage disruption
- **GE:** simultaneously solve for average and marginal tax rates (IDE)
  - key: marginal tax rate directly affects welfare, even conditional on ATR
  - because changes in labor supply (MTR) impact wages, and hence utility
  - progressive reform at rate = ratio of labor demand vs. supply elasticities
- Application: compensating the impact of robots [data: Acemoglu Restrepo 17]
  - other possible applications: immigration, international trade, etc
  - alternative strand in the literature: optimal taxation of robots
    Guerreiro Rebelo Teles 17, Thuemmel 18, Costinot Werning 18

Outline

1. The Welfare Compensation Problem

2. Designing the Compensating Tax Reform

3. Application: Compensating the Impact of Robots

Initial equilibrium

- Individuals $i \in [0,1]$: wage w_i, labor supply l_i, income tax $T(w_i l_i)$

$$\text{welfare:} \qquad U_i = \max_{l_i > 0} \; u_i\left(w_i l_i - T(w_i l_i)\,,\, l_i\right)$$

- Endogenous labor supply: first-order condition

$$\text{labor supply:} \qquad l_i \quad \text{satisfies} \quad -\frac{u'_{i,l}(c_i, l_i)}{u'_{i,c}(c_i, l_i)} = \left[1 - T'(w_i l_i)\right] w_i$$

- Endogenous wage: marginal product of aggregate labor input

$$\text{wage:} \qquad w_i = \mathscr{F}'_i(\{L_j\}_{j \in [0,1]})$$

- Government tax revenue $\mathscr{R}$ given the tax schedule T

- **In the paper:** endogenous participation, unequal capital ownership

Wage disruptions and tax reforms

- Disruption of wage distribution in arbitrary direction $\{\hat{w}_i^E\}_{i\in[0,1]}$
  - e.g, due to exogenous change $\hat{\mathscr{F}}$ in the production function (tech change)
  - size of the disruption $\mu > 0 \rightsquigarrow$ on impact: perturbed wage $w_i\left(1+\mu\hat{w}_i^E\right)$
  - government implements tax reform $\hat{T} \rightsquigarrow$ perturbed tax schedule $T+\mu\hat{T}$
- Equilibrium: agents adjust labor supply which further impacts wages etc
  - $\{\hat{w}_i, \hat{l}_i\}_{i\in[0,1]}$: total endogenous $\%$ changes in wages and labor supplies
  - $\{\hat{U}_i\}_{i\in[0,1]}$: welfare gains or losses after disruption and tax reform
- Welfare compensation problem: find $\hat{T}$ s.t. $\hat{U}_i = 0\ \forall i$ in new equilibrium
  - focus on marginal disruptions in the direction $\hat{\boldsymbol{w}}^E$: size $\mu \to 0$
  - once we solve for $\hat{T}$, deriving the fiscal surplus is straightforward

Outline

Compensation in Partial Equilibrium

- Partial equilibrium: no further endogenous wage adjustments: $\hat{w}_i = 0 \; \forall i$
  - marginal disruption $\rightsquigarrow$ change in the indirect utility $\hat{U}_i = 0$ of agent i is

$$0 \quad = \quad \left[\left(1 - T'\left(w_i l_i\right)\right) w_i l_i\right] \hat{w}_i^E - \hat{T}\left(w_i l_i\right)$$

1. exogenous wage change $\hat{w}_i^E$ weighted by the retention rate $1 - T'\left(w_i l_i\right)$
2. absolute tax change $\hat{T}\left(w_i l_i\right)$, which makes him poorer iff it is positive

- **Envelope thm:** in PE, the marginal tax rate change $\hat{T}'\left(w_i l_i\right)$ does not matter for welfare, conditional on the average tax rate change $\hat{T}\left(w_i l_i\right)$
  - key: to a first order, indirect utility moves one-for-one with total tax bill
  - immediately get compensating tax reform $\hat{T}$ following any disruption $\hat{\boldsymbol{w}}^E$
  - adjust ATR by income change due to disruption $\frac{\hat{T}(y_i)}{y_i} = \left(1 - T'\left(y_i\right)\right) \hat{w}_i^E$

Compensation in General Equilibrium

- **GE:** linearizing the zero-compensating-variation condition $\hat{U}_i = 0$ yields

$$0 \quad = \quad \left[\left(1 - T'\left(w_i l_i\right)\right) l_i\right] \left(\hat{w}_i^E + \hat{w}_i\right) - \hat{T}\left(w_i l_i\right)$$

  - wage change $\hat{w}_i$ determined by labor supply adjustments $\{\hat{l}_j\}_{j\in[0,1]}$
    [decreasing MPL and skill complementarities in production]
  - in turn each $\hat{l}_i$ determined by MT and AT changes $\{\hat{T}'\left(y_j\right), \hat{T}\left(y_j\right)\}_{j\in[0,1]}$
    [standard disincentive effects of distortionary taxes + cross-wage effects]

- **Key:** In GE, changes in labor supply, and hence in MTR, have 1st-order welfare effects despite the envelope theorem because they impact wages
  - higher marginal tax rate raises utility: hours $\downarrow$ & wage $\uparrow$ [cf. Stiglitz 82]

Compensation in General Equilibrium

- Compensating reform $\hat{T}$ solution to functional (integro-differential) eqn
  - **main result:** solve for reform $\hat{T}$ (and fiscal surplus) in closed-form

- Key elasticities entering the welfare compensation formula:
  based on the analysis of Sachs Tsyvinski Werquin 2017
  - labor supply elasticities of l_i wrt retention rate, wage: $\varepsilon_i^{S,r}, \varepsilon_i^{S,w}$ [Hicks]
  - labor supply elasticity of l_i wrt non-labor income: $\varepsilon_i^{S,n}$ [income effect]
  - cross-wage elasticity of w_j wrt L_i: γ_{ji} [skill complementarities in prod.]
    γ_{ji} discontinuous at $j \approx i$
  - own-wage elasticity of w_i wrt L_i: $\frac{1}{\varepsilon_i^D}$ [decreasing mg product of labor]
    inverse elasticity of labor demand

Compensation in General Equilibrium

- **Proposition:** The compensating tax reform is given in closed-form by

$$\frac{\hat{T}(y_i)}{y_i} = (1 - T'(y_i)) \left[\int_i^1 \mathscr{E}_{ij} \, \hat{\Omega}_j^E dj + \Lambda_i \right]$$

where: $\hat{\Omega}_j^E$ is the modified wage disruption variable

accounts for incidence of the initial shock $\hat{w}_i^E$ (labor demand spillovers)

where: Λ_i is the compensation-of-compensation variable

series $\Lambda_i = \sum_n \Lambda_i^{(n)}$ of compensations. Λ constant with CES: uniform shift in MTR

where: $\mathscr{E}_{ij}$ is the progressivity variable

implies a progressive compensating reform: $\mathscr{E}_{ij} \propto y_i^{\varepsilon^D/\varepsilon^{S,r} - p}$ if CES/CRP

Progressivity of the compensating tax reform

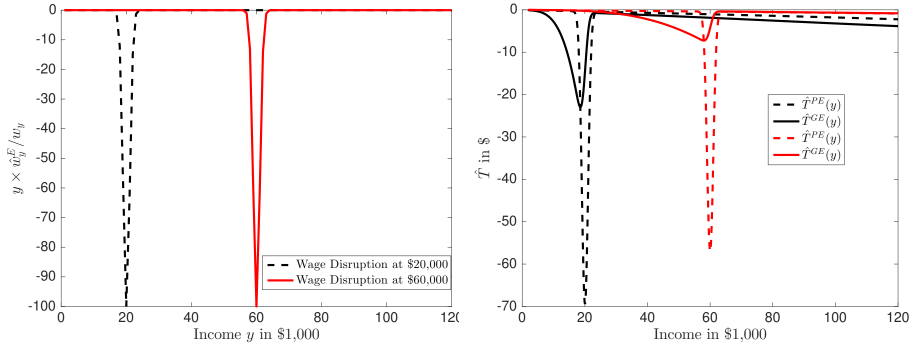
- $\mathscr{E}_{ij}$: assume decreasing MPL, infinite substitutability between skills
  - in PE, the compensating tax reform is $\frac{\hat{T}(y_i)}{y_i} = (1 - T'(y_i))\, \hat{w}_i^E$
  - in GE, ATR must compensate both the wage disruption and the welfare effects generated endogenously by the marginal tax rate changes

$$\frac{\hat{T}(y_i)}{y_i} = \left(1 - T'(y_i)\right) \hat{\Omega}_i^E + [1 + \frac{\varepsilon^D}{\varepsilon^{S,r}} - p]^{-1}\, \hat{T}'(y_i)$$

- Progressive reform b/c any AT hike must be compensated by MT hike
  - rate of progressivity = labor demand elasticity ÷ labor supply elasticity − rate of progressivity of the initial tax schedule
  - key: this ratio determines how much ↑ mg tax rate ↑ wage and utility

Graphical representation

- Calibration: QL / CELS utility, CES production, CRP tax code
  $\rightsquigarrow$ disruption: $\$100$ gross income loss at levels $\$20,000$ and $\$60,000$



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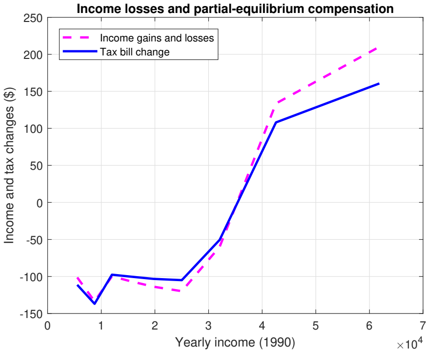
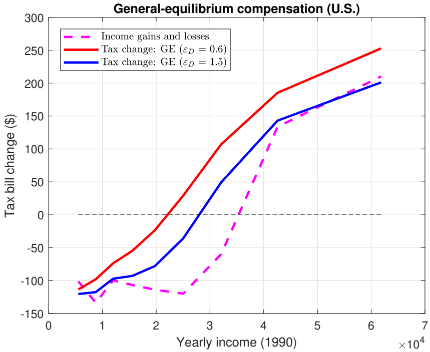
Automation in the U.S., 1990-2007

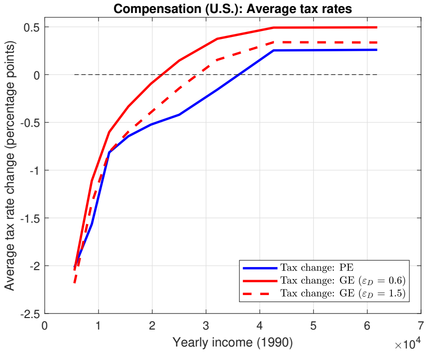
- Quantitative application based on Acemoglu and Restrepo (2017)
  1990-2007: one additional robot per 1000 workers



Compensation of automation

- Compensation: tax bill changes by -112% of income loss at 10^{th} centile, $+124\%$ of income gain at 90^{th} centile, fiscal surplus ≈ 0





Conclusion

- Classic PF question: economic shock generally creates winners and losers

  Kaldor 39, Hicks 39/40, Kaplow 04/12, Hendren 14

  - design a compensating tax reform and evaluate its fiscal surplus
  - closed-form in general equilibrium with only distortionary taxes

- Applications: automation, job polarization, immigration, int'l trade

  Acemoglu Restrepo 17, Goos et al 14, Dustmann Frattini Preston 13, Antras Gortari Itshkoki 17

  - need GE framework: relative wages determined by relative supply of skills

- Advantages of compensation principle over optimal taxation

  Stiglitz 82, Rothschild Scheuer 13/16, Ales Kurnaz Sleet 15

  - no need to choose a particular social welfare function
  - tractability (closed form) in more general environments
  - policy-relevance: work with actual tax system and observable variables