Generalized Compensation Principle

Aleh Tsyvinski[1] **Nicolas Werquin**[2]

[1]Yale University

[2]Toulouse School of Economics

Becker Friedman Institute, May 2018

Introduction

- An economic disruption typically creates winners and losers
    - e.g., technological change, immigration inflow, trade liberalization
    - more generally, any shock that affects the wage distribution

- Welfare compensation problem:
    - can we design a reform of the tax-and-transfer system ...
    - that offsets these losses by redistributing the gains of the winners ...
    - 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
    - simple implementation if lump-sum taxes are available policy instruments

Introduction

- First limitation of the Kaldor-Hicks criterion:
  - in practice, tax instruments are distortionary [Mirrlees 1971]
  - asymmetric information: only an income tax is available
- Second limitation: for many disruptions we need general equilibrium
  - e.g., consider an immigration inflow: no welfare impact in PE
  - in GE, a higher supply of labor affects the wage distribution through: (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 an immigration inflow ...
  - this generates further welfare gains and losses that need to be themselves compensated using the tax code $\rightsquigarrow$ complex fixed point problem

Introduction

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

Outline

1. The Welfare Compensation Problem

2. Design of 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 [FOC]

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

- Endogenous wage: marginal product of aggregate labor input [MPL]

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

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

- **in the paper:** endogenous participation decisions, capital ownership

Wage disruptions and tax reforms

- Arbitrary disruption $\hat{\boldsymbol{w}}^E = \{\hat{w}_i^E\}_{i\in[0,1]}$ of the wage distribution $\boldsymbol{w}$
  - e.g, due to exogenous change $\hat{\mathscr{F}}$ in the production function (tech change)
  - before agent i adjusts behavior $\rightsquigarrow$ perturbed wage is $w_i\left(1+\mu\hat{w}_i^E\right)$
  - government implements tax reform $\hat{T}$ $\rightsquigarrow$ perturbed tax schedule $T+\mu\hat{T}$
- New equil. $(\{w_i(1+\mu\hat{w}_i^E+\mu\hat{w}_i)\}, \{l_i(1+\mu\hat{l}_i)\}, \{U_i+\mu\hat{U}_i\}, T+\mu\hat{T})$
  - individuals adjust labor supply, which further impacts their wage, etc
  - $\{\hat{w}_i\}_{i\in[0,1]}$: total endogenous (percentage) changes in wages ▸ formal
- Welfare compensation problem: find $\hat{T}$ s.t. $\hat{U}_i = 0$ $\forall i$ in new equil.
  - 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 $\hat{\mathscr{R}}$ is straightforward

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Welfare compensation in PE

- Partial equilibrium (exogenous wages): $\mathscr{F}(\{L_i\}_{i\in[0,1]}) = \int_0^1 \theta_i L_i di$
  - exogenous disruption $\hat{\boldsymbol{w}}^E$ induces no further adjustment: $\hat{w}_i = 0 \ \forall i$

- Marginal wage disruption: linearize the condition $\hat{U}_i = 0$ as $\mu \to 0$

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

  - in PE, the change in the indirect utility $\hat{U}_i$ of agent i is due to:
    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 $\hat{T}\left(w_i l_i\right)$
  - immediately get compensating tax reform $\hat{T}$ following any disruption $\hat{\boldsymbol{w}}^E$

Elasticities

- **Conclusion:** compensating tax reform with distortionary taxes in PE
  - adjust average tax rate by the net income gain or loss due to disruption

$$\frac{\hat{T}\left(y_i\right)}{y_i} = \left(1 - T'\left(y_i\right)\right) \hat{w}_i^E$$

- **GE:** tax formulas in terms of standard (observable) elasticities ▸ formal
  - 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

Welfare compensation problem in GE

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

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

  - MPL: endogenous wage adjustment $\hat{w}_i = -\frac{1}{\varepsilon_i^D} \hat{l}_i + \int_0^1 \gamma_{ij} \hat{l}_j dj$

  - FOC: total labor supply adjustment $\hat{l}_i = \hat{l}_i^{\mathbf{pe}} + \varepsilon_i^{S,w} \int_0^1 \Gamma_{ij} \hat{l}_j^{\mathbf{pe}} dj$

    elasticity Γ_{ij} accounts for infinite series of cross-wage effects [Sachs Tsyvinski Werquin 17]

  - where PE incidence: $\hat{l}_i^{\mathbf{pe}} = \varepsilon_i^{S,w} \hat{w}_i^E - \varepsilon_i^{S,r} \frac{\hat{T}'(y_i)}{1 - T'(y_i)} + \varepsilon_i^{S,n} \frac{\hat{T}(y_i)}{(1 - T'(y_i)) y_i}$

- **Key:** In GE, changes in labor supply, and hence in MTR, have 1^{st}-order welfare effects despite the envelope theorem because they impact wages

  - higher marginal tax rate raises utility: hours ↓ & wage ↑ [cf. Stiglitz 82]

Welfare compensation in GE: Solution

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

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

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

formal 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 in closed-form)

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

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

formal 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 tax rates)

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

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

  - suppose agents $i < i^*$ are undisrupted $\rightsquigarrow$ progressive tax reform, because in GE, an average tax hike must be compensated by a marginal tax hike

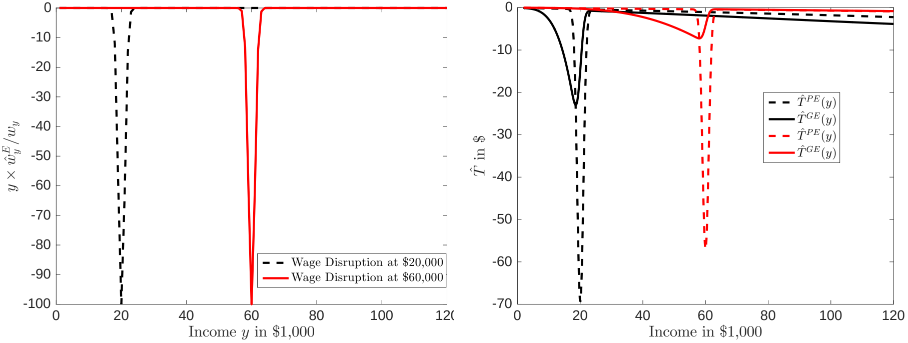
- Consequence [ODE]: ATR evolve below y_{i^*} at constant rate $\frac{\varepsilon^D}{\varepsilon^{S,r}} - p > 0$

$$\frac{\hat{T}(y_i)}{y_i} \propto y_i^{\varepsilon^D / \varepsilon^{S,r} - p}\, \mathbb{I}_{\{y_i \leq y_{i^*}\}}$$

  - rate of progressivity: labor demand elasticity $\div$ labor supply elasticity
  - key: this ratio determines how much $\uparrow$ mg tax rate $\uparrow$ wage / utility

Graphical representation

- Calibration: constant elasticities $(\varepsilon, \sigma, p) = (0.33\,,\,0.6\,,\,0.156)$ compensation of a \$100 gross income loss at $y_{i^*} = \$20\text{K}, \$60\text{K}$



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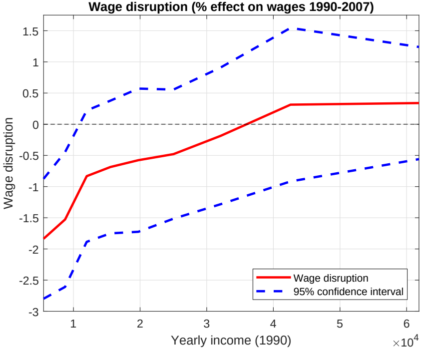
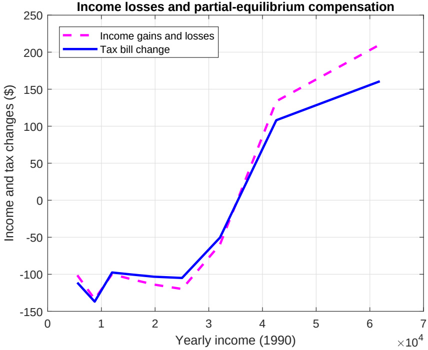
Automation in the U.S., 1990-2007

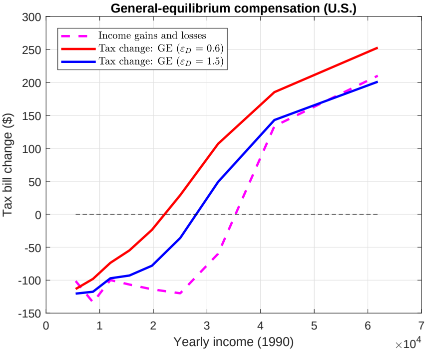
- Quantitative application based on Acemoglu and Restrepo (2017)
  1990-2007: one additional robot per 1000 workers

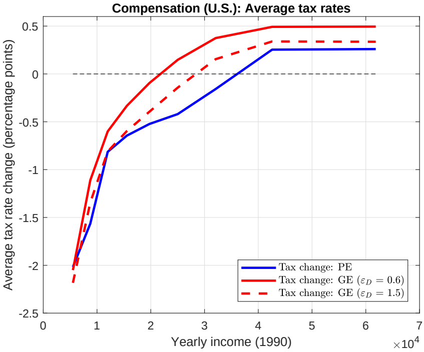




Compensation in GE

- Compensating tax changes: $-\$113$ at 10^{th} centile (112% income loss), $+\$260$ at 90^{th} percentile (124% income gain) $\rightsquigarrow$ fiscal surplus \$16





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 tax reform in general equilibrium with only distortionary taxes
  - more generally: compensate so that welfare of agent i changes by $h_i \in \mathbb{R}$
- Applications: automation, job polarization, immigration, intl 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, Sachs Tsyvinski Werquin 16
  - policy-relevance: work with actual tax system and observable variables
  - tractability (closed form) in much more general environments
  - no need to choose a particular social welfare function