Taxing Capital in the Presence of Trickle-Down Effects

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Teaching Slides

Introduction

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- Extensive policy debate on 'trickle-down' effects
  $\Rightarrow$ capital taxes $\downarrow$ $\Rightarrow$ investment $\uparrow$ $\Rightarrow$ labor demand $\uparrow$ $\Rightarrow$ wages $\uparrow$

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- Capital taxes reduce inequality but cause deadweight losses
  $\Rightarrow$ equity-efficiency trade-off
- Extensive policy debate on 'trickle-down' effects
  $\Rightarrow$ capital taxes $\downarrow$ $\Rightarrow$ investment $\uparrow$ $\Rightarrow$ labor demand $\uparrow$ $\Rightarrow$ wages $\uparrow$

$\Rightarrow$ Illustrate interplay of these forces in determining optimal capital tax rates

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  - special cases: Piketty and Saez 2013, Saez and Stantcheva 2018

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  - decomposition of distributional effects and efficiency losses
  - isolates contribution of general equilibrium ('trickle-down') effects

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  - analytical derivation in terms of sufficient statistics
  - decomposition of distributional effects and efficiency losses
  - isolates contribution of general equilibrium ('trickle-down') effects
- Optimal capital taxes for large range of social welfare criteria

Model - Households

- Infinitely lived agents with time-constant deterministic ability η and initial wealth (capital) k_0; joint distribution $\Gamma(k_0, \eta)$

- Preferences
  - utility $u(c, l)$ depends on consumption and labor supply
  - standard assumptions: $u_c > 0, u_{cc} < 0, u_l \leq 0, u_{ll} < 0$
  - time-discount factor $\beta < 1$

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- Capital- and labor income of type (k_0, η)

$$y_t^k(k_0, \eta) = r_t k_t \qquad y_t^l(k_0, \eta) = w_t \eta l_t$$

where r is gross interest and w is wage per efficiency unit of labor

Model - Households

- Optimization problem:

$$\max_{c_t, k_{t+1}, l_t} \sum_{t=0}^{\infty} \beta^t u(c_t, l_t)$$

$$\text{s.t. } k_{t+1} + c_t = (1 + (1 - \tau_k) r_t) k_t + w_t \eta l_t - \tau_l (w_t \eta l_t) + T_t \quad \forall t$$

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- Policy instruments:
  - linear capital tax rate τ_k
  - differentiable labor tax code $\tau_l(.)$
  - lump-sum transfer T

Model - Firms

- Employ capital K and labor L to maximize profits

$$\max_{K_t \geq 0, L_t \geq 0} \{F(K_t, L_t) - (r_t + \delta)K_t - w_t L_t\}$$

- Capital depreciates at rate δ each period

- Constant returns to scale production function F
  - standard assumptions: $F_k, F_l > 0$; $F_{kl} \geq 0$; $F_{kk}, F_{ll} \leq 0$
  - capital-labor substitution elasticity $\sigma > 0$
  - special case with constant prices: $F_{kl} = F_{kk} = F_{ll} = 0 \Rightarrow \sigma = \infty$

- First order condition gives factor prices

$$r_t = F_k(K_t, L_t) - \delta \qquad w_t = F_l(K_t, L_t)$$

Factor Shares

- Firms' **expenditure** shares:

$$\tilde{\alpha}_t^k = \frac{(r_t + \delta)K_t}{(r_t + \delta)K_t + w_t L_t} \qquad \tilde{\alpha}_t^l = \frac{w_t L_t}{(r_t + \delta)K_t + w_t L_t}$$

- Households' **income** shares:

$$\alpha_t^k = \frac{r_t K_t}{r_t K_t + w_t L_t} \qquad \alpha_t^l = \frac{w_t L_t}{r_t K_t + w_t L_t}$$

Equilibrium and Steady State

Equilibrium:

- Factor markets clear

$$K_t = \int k_t(k_0, \eta) d\Gamma \qquad L_t = \int \eta l_t(k_0, \eta) d\Gamma$$

- Government budget clears

$$T_t + G = \tau_k r_t K_t + \int \tau_l(y_t^l(k_0, \eta)) d\Gamma$$

where $G > 0$ is exogenous stream of government expenditures

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Steady state:

- The economy is in steady state when

$$(r_t, w_t, T_t, k_t(k_0, \eta), l_t(k_0, \eta)) = (r_0, w_0, T_0, k_0, l_0(k_0, \eta)) \qquad \forall t, \eta$$

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- **Assumption:** in period $t = -1$ the economy is in steady state

The Policy Experiment

- Government announces one-off change in τ_k at $t = 0$
- Transfer T adjusts to ensure period-by-period government budget clearing
- Agents have perfect foresight

Planner's Problem

- Planner maximizes social welfare W, assigns Pareto weights $\omega(k_0, \eta)$

$$\max_{\tau_k} W = \int \omega(k_0, \eta) \sum_{t=0}^{\infty} \beta^t u\big(c_t(k_0, \eta), l_t(k_0, \eta)\big) d\Gamma$$

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- Marginal social welfare weights

$$g(k_0, \eta) = \omega(k_0, \eta) u_c(k_0, \eta)$$

- Normalization: value of a marginal dollar distributed equally

$$\bar{g} = \int g(k_0, \eta) d\Gamma = 1$$

Some Notation

- Capital- / labor income weighted average marginal social welfare weights

$$\bar{g}^k = \frac{\int g(k_0, \eta) y^k(k_0, \eta) d\Gamma}{Y^k} \qquad \bar{g}^l = \frac{\int g(k_0, \eta) y^l(k_0, \eta) d\Gamma}{Y^l}$$

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- Labor income weighted average marginal labor tax rate

$$\bar{\tau}_l' = \frac{\int y^l(k_0,\eta) \tau_l' \big(y^l(k_0,\eta)\big) d\Gamma}{Y^l}$$

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$$\tilde{g}^l = \frac{\int g(k_0,\eta)\big(1-\tau_l'(y^l(k_0,\eta))\big) y^l(k_0,\eta) d\Gamma}{(1-\bar{\tau}_l')Y^l}$$

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- Special case: linear labor taxes $\Rightarrow \tilde{g}^l = \bar{g}^l$

Elasticities of Equilibrium Variables

- Elasticity / semi-elasticity of any period-t equilibrium variable x_t with respect to $1-\tau_k$:

$$\epsilon_{x_t,1-\tau_k} = \frac{d\ln x_t}{d\ln(1-\tau_k)} \qquad \varepsilon_{x_t,1-\tau_k} = \frac{d\ln x_t}{d(1-\tau_k)}$$

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- Time-discounted averages:

$$\bar{\epsilon}_{x,1-\tau_k} = (1-\beta)\sum_{t=0}^{\infty}\beta^t \epsilon_{x_t,1-\tau_k} \qquad \bar{\varepsilon}_{x,1-\tau_k} = (1-\beta)\sum_{t=0}^{\infty}\beta^t \varepsilon_{x_t,1-\tau_k}$$

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⇒ All policy elasticities (Hendren 2016)

- ❏ causal effect of tax reform taking all simultaneous equilibrium adjustments into account
- ❏ not directly measurable
- ❏ recover them from actually estimated *supply* elasticities

Local Welfare Effect

- Money measured welfare change per dollar of mechanically raised revenue

$$\frac{dW}{Y^k d\tau_k} = EQ - MEB$$

- **Equity effect** EQ: planner's valuation of the achieved redistribution

  $\Rightarrow$ normative component: depends on choice of social welfare weights

- **Marginal excess burden** MEB: loss in revenue through change in agents' behaviour (deadweight loss)

  $\Rightarrow$ positive component: independent of social welfare criterion

Equity Effect

$$EQ = \underbrace{(1-\bar{g}^k)}_{EQ_M} + \underbrace{\frac{\bar{\varepsilon}_{K,1-\tau_k} - \bar{\varepsilon}_{L,1-\tau_k}}{\sigma}\tilde{\alpha}^k \frac{\alpha^l}{\alpha^k}\left[(1-\tau_k)\bar{g}^k - (1-\bar{\tau}_l')\tilde{g}^l + \tau_k - \bar{\tau}_l'\right]}_{EQ_P}$$

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  - positive impact of rise in r on net capital income $(1-\tau_k)\bar{g}^k > 0$
  - negative impact of decline in w on net labor income $-(1-\bar{\tau}_l')\tilde{g}^l < 0$
  - ambiguous impact of price changes on transfers $(\tau_k - \bar{\tau}_l')\bar{g} = \tau_k - \bar{\tau}_l'$

Marginal Excess Burden

$$MEB = \underbrace{\tau_k \bar{\varepsilon}_{K,1-\tau_k}}_{MEB_K} + \underbrace{\frac{\mathrm{E}[\tau_l' y^l \bar{\varepsilon}_{l,1-\tau_k}]}{Y^k}}_{MEB_L}$$

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  - loss in capital income tax revenue because agents save less

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- **Revenue loss through investment decline** $MEB_K > 0$
  - loss in capital income tax revenue because agents save less
- **Revenue change through change in labor supply** MEB_L
  - change in labor income tax revenue
  - generally ambiguous sign
  - without income effects $MEB_L \geq 0$ (assumed below)

A Test for Optimality

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$$+\frac{\alpha^l}{\alpha^k}\frac{\tilde{\alpha}^k}{\sigma}\left(1-\frac{\bar{\varepsilon}_{L,1-\tau_k}}{\bar{\varepsilon}_{K,1-\tau_k}}\right)\left[(1-\tau_k)\tilde{g}^k-(1-\bar{\tau}_l')\tilde{g}^l+\tau_k-\bar{\tau}_l'\right]$$

- Second term drops out in constant price case ($\sigma = \infty$)
  - cf. Piketty and Saez 2013, Section 3; Saez and Stantcheva 2018, Section 5

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- Important: only local result (Kleven 2021)
  - sufficient statistics are endogenous to τ_k
  - may change with larger tax reforms

Recovering Unmeasured Policy Elasticities

- For quantification need to assign values to the sufficient statistics
- **Problem:** $\epsilon_{K_t,1-\tau_k}$, $\epsilon_{L_t,1-\tau_k}$ are unmeasured policy elasticities (Hendren 2016)
- Summarize overall reaction of K, L taking responses to joint adjustments in T, w, r into account
- Impossible to measure directly
- **Solution:** derive mapping of $\epsilon_{K_t,1-\tau_k}$, $\epsilon_{L_t,1-\tau_k}$ to actually estimated elasticities of capital- and labor *supply*

Supply Elasticities

- Let $X = \{1 - \tau_k, \{w_s, r_s, T_s\}_{s=0}^{\infty}\}$

- Supply elasticities of period-t capital / labor with respect to $x \in X$:

$$\tilde{\epsilon}_{K_t,x} = \left.\frac{\partial \ln K_t}{\partial \ln x}\right|_{X \setminus x} \qquad \tilde{\epsilon}_{L_t,x} = \left.\frac{\partial \ln L_t}{\partial \ln x}\right|_{X \setminus x}$$

- measure change in households' **supply** of capital / labor to a change in x **only** (holding all other taxes, transfers and prices fixed)

Recovering Unmeasured Policy Elasticities

- Elasticities of equilibrium quantities can be decomposed as weighted sums of supply elasticities

- E.g. net-of-tax elasticity of equilibrium capital in period t:

$$\epsilon_{K_t,1-\tau_k} = \tilde{\epsilon}_{K_t,1-\tau_k} + \sum_{s=0}^{\infty} \tilde{\epsilon}_{K_t,T_s} \epsilon_{T_s,1-\tau_k} + \sum_{s=0}^{\infty} \tilde{\epsilon}_{K_t,r_s} \epsilon_{r_s,1-\tau_k} + \sum_{s=0}^{\infty} \tilde{\epsilon}_{K_t,w_s} \epsilon_{w_s,1-\tau_k}$$

- Weights $\{\epsilon_{T_s,1-\tau_k}, \epsilon_{r_s,1-\tau_k}, \epsilon_{w_s,1-\tau_k}\}_{s=0}^{\infty}$ are linear functions of $\{\epsilon_{K_s,1-\tau_k}\}_{s=0}^{\infty}$ and $\{\epsilon_{L_s,1-\tau_k}\}_{s=0}^{\infty}$

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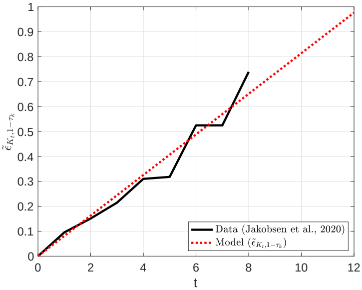
$\Rightarrow$ Linear system with as many equations and unknowns

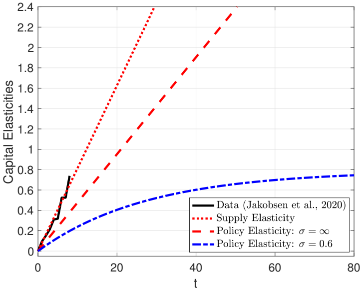
$\Rightarrow$ Obtain mapping from the unmeasured policy elasticities $\epsilon_{K_t,1-\tau_k}$ and $\epsilon_{L_t,1-\tau_k}$ to estimable supply elasticities

The Net-of-Tax-Elasticity of Capital Supply



- Model predicts linearity in time of $\tilde{\epsilon}_{K_t,1-\tau_k}$
- Consistent with quasi-experimental evidence (Jakobsen et al. 2020)
- Assign value $\tilde{\epsilon}_{K_1,1-\tau_k}$ to best match slope

The Elasticity of the Equilibrium Capital Stock



- Policy elasticity **always lower** than supply elasticity

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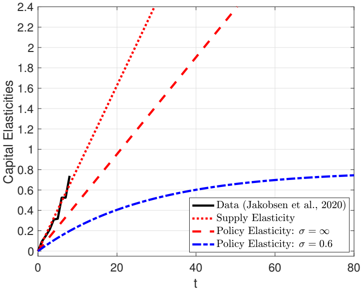

- Policy elasticity **always lower** than supply elasticity
- With $\sigma = \infty$ (constant prices) solely due to income effect on capital accumulation induced by simultaneous change in T

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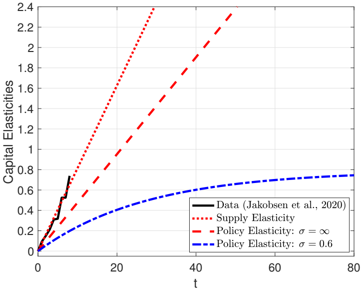

- Policy elasticity **always lower** than supply elasticity

- With $\sigma = \infty$ (constant prices) solely due to income effect on capital accumulation induced by simultaneous change in T

- With $\sigma < \infty$ also due to substitution effect from change in r
  - lesser impact of income effects induced by changes in w, r

Quantification: Sufficient Statistics

Suff. Stat.		Value		Note
$\tilde{\alpha}^k$		0.4000		Capital expenditure share
α^k		0.2980		Capital income share
$\bar{\tau}_l'$		0.2250		Wgt. av. marg. labor tax rate
τ_k		0.4150		Initial capital income tax rate
$\tilde{\epsilon}_{L,w}$		0.3755		Elasticity of agg. labor supply
$\mathrm{E}[\tau_l' y^l \tilde{\varepsilon}_{l,w}]/Y^l$		0.0845		Wgt. av. labor supply elasticity
r		0.0658		Return on capital
$\tilde{\epsilon}_{K_1,1-\tau_k}$		0.0814		Tax-elasticity of capital supply
σ	0.6000	1.0000	∞	Cap.-labor substitution elasticity
$\bar{\epsilon}_{K,1-\tau_k}$	0.3778	0.4890	1.2368	Policy elasticity capital
$\bar{\epsilon}_{L,1-\tau_k}$	0.0756	0.0639	0.0000	Policy elasticity labor

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Consider three values for σ

- Baseline ($\sigma = 0.6$, Oberfield and Raval 2021)
- Cobb-Douglas ($\sigma = 1$)
- Perfect substitutes ($\sigma = \infty$) $\Rightarrow$ constant r, w

Marginal Excess Burden

	MEB_K	MEB_L	MEB
Constant prices ($\sigma = \infty$)	0.8774	0.0000	0.8774
Cobb-Douglas ($\sigma = 1$)	0.3469	0.0584	0.4053
Baseline ($\sigma = 0.6$)	0.2680	0.0692	0.3372

- First round effect: $\tau_k \uparrow \Rightarrow (1-\tau_k)r \downarrow \Rightarrow$ supply of $K \downarrow$

Marginal Excess Burden

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- GE feedback effects with $\sigma < \infty$
  - $r \uparrow \Rightarrow$ mitigates first round effect $\Rightarrow$ lower MEB_K

Marginal Excess Burden

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  - demand for $L \downarrow \Rightarrow w \downarrow \Rightarrow$ supply of $L \downarrow \Rightarrow$ larger MEB_L

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- effect on MEB_K is order of magnitude larger than effect on $MEB_L \Rightarrow$ lower σ implies lower MEB

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- effect on MEB_K is order of magnitude larger than effect on $MEB_L \Rightarrow$ lower σ implies lower MEB

$\Rightarrow$ deadweight loss of capital tax hikes is smaller precisely when 'trickle-down' effects are stronger

Equity Effect

- Equity effect depends on welfare criterion
- Consider 100 different welfare functions: each concentrates the whole weight on a particular percentile of the US income distribution
  - analogous to Piketty and Saez 2013 for bequest distribution
- Data from US Survey of Consumer Finances 2022

Equity Effect

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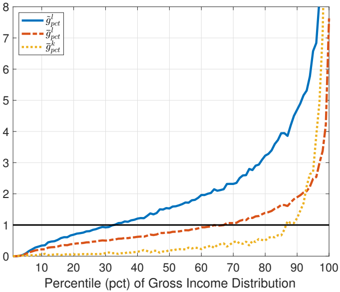
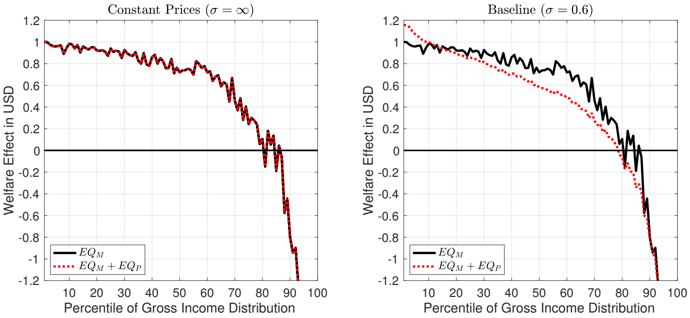
- Following graph depicts
  - $\bar{g}^k_{pct}$: capital income earned by percentile pct of the total income distribution as fraction of capital income in the whole population
  - $\bar{g}^l_{pct}$: analogous for labor income
  - $\tilde{g}^l_{pct}$: average net-of-marginal-tax-weighted labor income earned by percentile pct relative to average in population

Marginal Social Welfare Weights

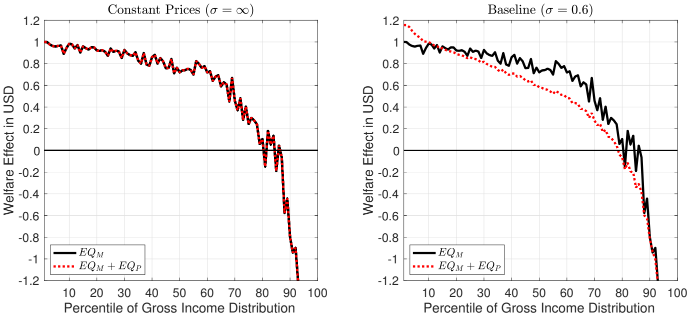


- Rawlsian planner assigns $\bar{g}^k = \bar{g}^l = \tilde{g}^l = 0$
- Welfare functions that value households higher up the income distribution assign positive values
- $\bar{g}^l$ increases quicker than $\bar{g}^k$ because labor income is less concentrated than capital income
- Quickest increase in $\tilde{g}^l$ because **net** labor income is even less concentrated due to progressive tax code

Equity Effect

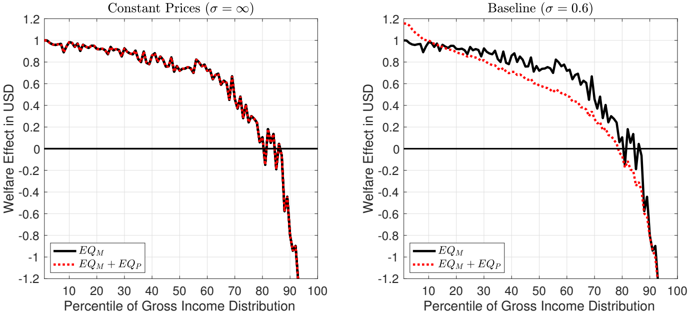


Equity Effect



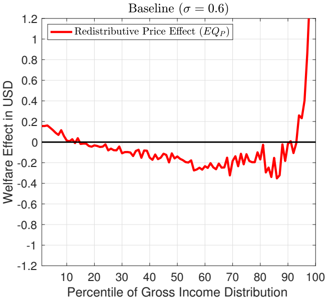
- Constant price case: $EQ_P = 0$
  - only mechanical effect $EQ = EQ_M = 1 - \bar{g}^k$
  - initially slow- then accelerating decline reflects concentration of capital at the top

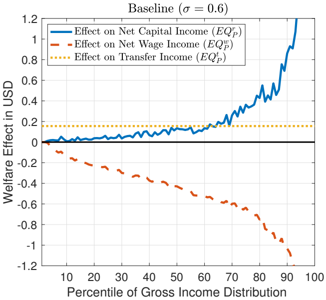
Equity Effect



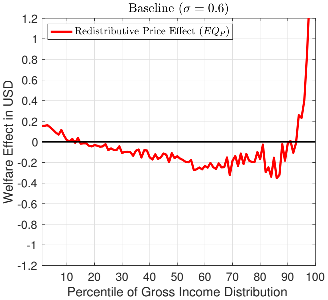
- Constant price case: $EQ_P = 0$
  - only mechanical effect $EQ = EQ_M = 1 - \bar{g}^k$
  - initially slow- then accelerating decline reflects concentration of capital at the top
- Baseline: price effect $EQ_P \neq 0$
  - measures welfare impact of $w \downarrow$ and $r \uparrow$
  - decomposed further on next slide

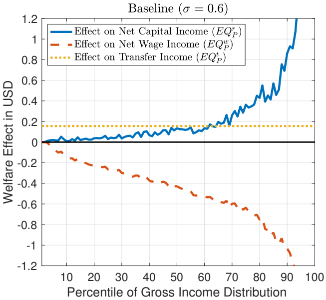
Price Effect





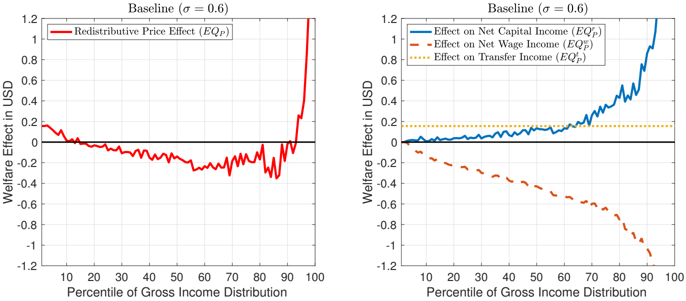
Price Effect





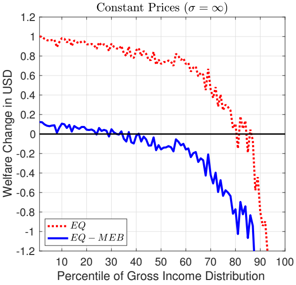
- $EQ_P > 0$ when welfare criterion values bottom or top 10% of income distribution
  - bottom benefits from larger transfers since initially $\tau_k > \bar{\tau}_l'$
  - top benefits from increase in net capital income due to $r \uparrow$

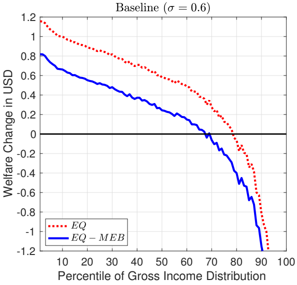
Price Effect



- $EQ_P > 0$ when welfare criterion values bottom or top 10% of income distribution
  - bottom benefits from larger transfers since initially $\tau_k > \bar{\tau}_l'$
  - top benefits from increase in net capital income due to $r \uparrow$
- Otherwise $EQ_P < 0$
  - percentiles 10 to 90 have mainly labor income and lose from $w \downarrow$

Total Welfare Effect





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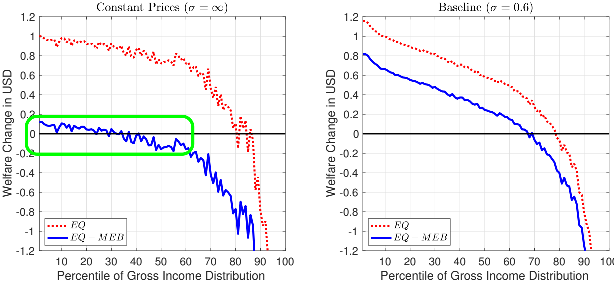
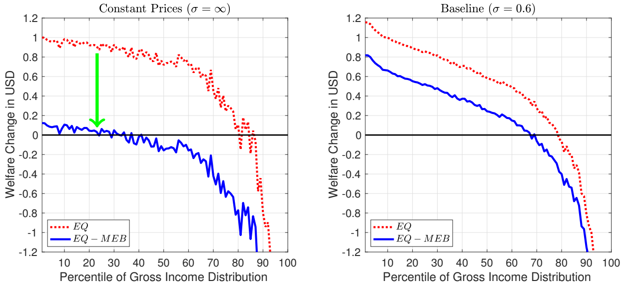


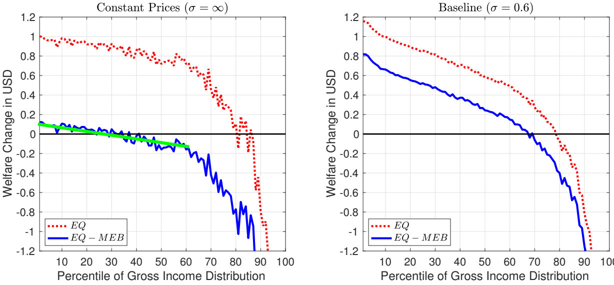
- Constant prices ($\sigma = \infty$): status quo capital tax close to optimal for bottom 60% of income distribution

Total Welfare Effect



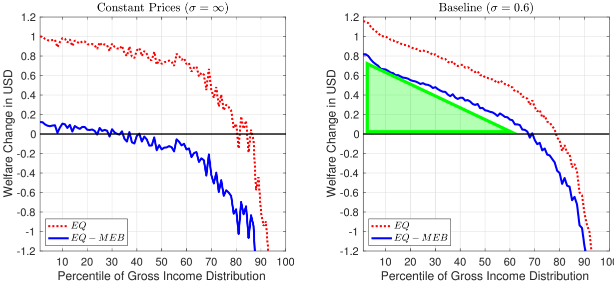
- Constant prices ($\sigma = \infty$): status quo capital tax close to optimal for bottom 60% of income distribution
  - large excess burden offsets mechanical distributional gain

Total Welfare Effect



- Constant prices ($\sigma = \infty$): status quo capital tax close to optimal for bottom 60% of income distribution
  - large excess burden offsets mechanical distributional gain
  - slow decline since this part of the population has little capital income

Total Welfare Effect



- Constant prices ($\sigma = \infty$): status quo capital tax close to optimal for bottom 60% of income distribution
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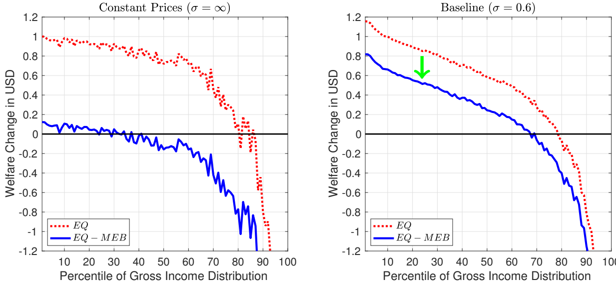
- With realistic factor complementarity bottom 60% actually benefit from tax increase

Total Welfare Effect



- Constant prices ($\sigma = \infty$): status quo capital tax close to optimal for bottom 60% of income distribution
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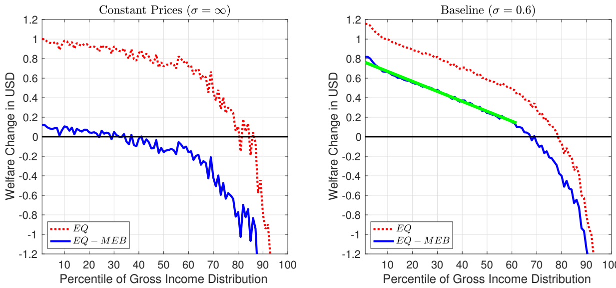
- With realistic factor complementarity bottom 60% actually benefit from tax increase
  - low excess burden $\Rightarrow$ more of the mechanically raised revenue can be spent on transfers

Total Welfare Effect



- Constant prices ($\sigma = \infty$): status quo capital tax close to optimal for bottom 60% of income distribution
  - ❏ large excess burden offsets mechanical distributional gain
  - ❏ slow decline since this part of the population has little capital income

- With realistic factor complementarity bottom 60% actually benefit from tax increase
  - ❏ low excess burden $\Rightarrow$ more of the mechanically raised revenue can be spent on transfers
  - ❏ stronger decline due to depressing effect on wages

Optimal Tax Rates

- Sufficient statistics approach valid only for small reforms
  - endogenous to tax changes (Kleven 2021)

- Hence now use fully specified (nested) parametric model
  - calibrate parameters so that model (locally) exactly matches estimates of welfare-relevant sufficient statistics
  - compute optimal capital tax rates for same set of social welfare functions

The Optimal Capital Tax Rate

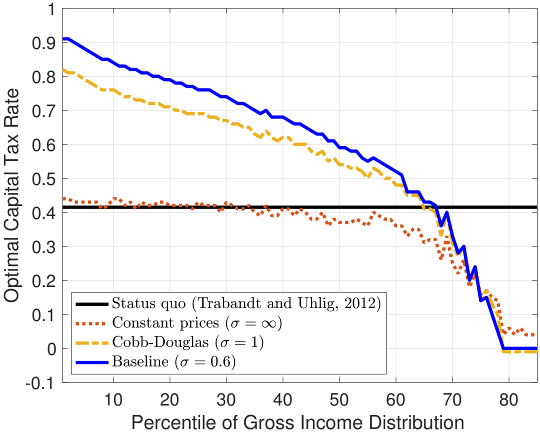


Figure: Optimal Capital Tax Rates: value p on the x-axis corresponds to the social welfare function that concentrates the whole welfare weight at percentile p of the total gross income distribution.

Conclusion

- Paper advances sufficient statistics approach to dynamic GE setting
- Strong discrepancies to policy prescriptions from existing formulas which assume constant prices
- Bottom 60% of US income distribution would benefit from capital tax increases
- Benefits strongly decline in labor income due to depressing effect on wages
- Both deadweight loss and redistributive price effects crucially depend on capital-labor substitution elasticity
- Qualitative insights carry over to
  - the case where the labor tax code is simultaneously optimized (see Section 7 in Mayr 2025)
  - a more general setting with uninsurable idiosyncratic risk to working- and investment ability (see Online Appendix B in Mayr 2025)

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