The Incidence of Capital Income Taxes in a Life Cycle Economy with Firm Heterogeneity

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Capital income taxation

1. Firm: Corporate income tax
   - Corporate income: total revenue - expenses and operating costs

2. Household: Personal income tax
   - Personal income: labor, **capital** and other incomes

     - Capital incomes: dividends, capital gains and interests

Capital tax reforms in the US

- Before 2003
  - Corporate income tax: 35%
  - Capital gains and dividend tax rates: 25%

- 2003: Job and Growth Tax Relief Reconciliation Act 2003: Bush's tax cuts
  - Corporate tax: Kept at 35%
  - Capital gains and dividend tax rates: Down to 15% (temporary)

- 2018: The US Tax Cuts and Jobs Act 2017: Trump's tax cuts
  - Corporate income tax: Down to 21%
  - Capital gains and dividend tax rates: 15%

The incidence of capital income taxes

- ▶ How is the burden of capital income taxation allocated among different households and generations?
    - ▶ Corporate income tax
    - ▶ Dividend tax
    - ▶ Capital gains tax

- ▶ How would a tax reform proposal affect each household group?
    - ▶ Efficiency vs. equity

This paper

- ▶ Provides a tax incidence analysis

- ▶ Using a dynamic general equilibrium model

- ▶ Key model features:
    - ▶ Heterogeneous households: Life cycle structure and productivity differences
    - ▶ Heterogeneous firms: Differences in real and financial positions
    - ▶ Dynamic general equilibrium

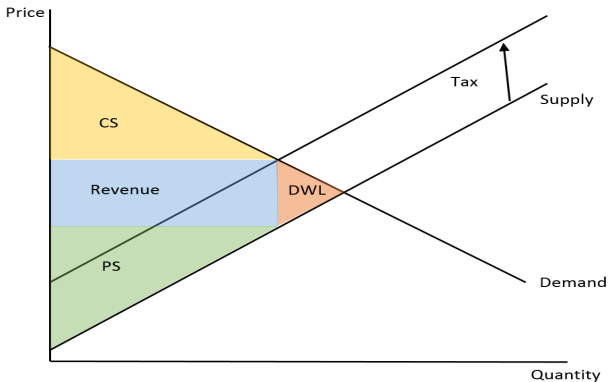# Excess burden or deadweight loss of taxation (DWL)

Figure: Measuring excess burden: Harberger's triangle

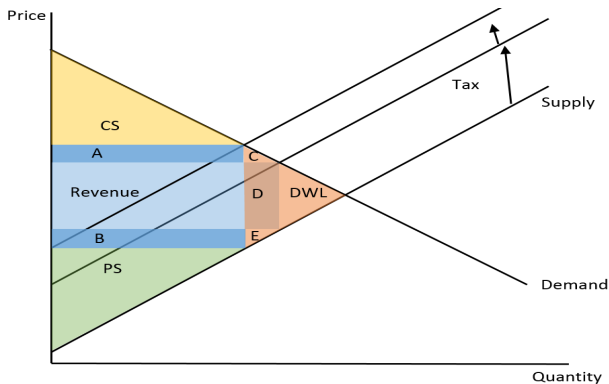# Harberger's triangle and marginal excess burden (MEB)

Figure: Marginal excess burden of a tax increases

- MEB $= \Delta$ welfare / Δ revenue $=$ (C+D+E)/(A+B-D).

A marginal excess burden (MEB) analysis in general equilibrium

- ▶ Measuring welfare costs
  - ▶ MEB=(Marginal change in welfare)/(Marginal change in revenue)
- ▶ quantify the incidence of three capital taxes
  - ▶ Corporate income tax (CIT), dividend tax (DT) and capital gain tax (CGT)

Main results

- The burden of the three capital taxes are large and significantly different.
  - The marginal excess burden (MEB)

- The burden of each capital tax is allocated unevenly among income groups and generations.

- The modeling features matter for the quantitative results
  - Firm heterogeneity
  - Life-cycle structure
  - Market incompleteness

- Cutting corporate tax leads to efficiency gains,
  - but opposing welfare effects across households and generations

Marginal excess burden (MEB): Efficiency effect

Model	CIT	DT	CGT	DT&CGT	LIT
Benchmark	$0.67	$1.56	-$0.28	$0.50	$0.22

Table: Marginal excess burden of raising 1 dollar revenue in NPV terms

- ▶ CIT: Corporate income tax;
- ▶ DT: Dividend tax;
- ▶ CGT: Capital gain tax;
- ▶ LIT: Labor income tax

Distribution of MEB: Distributive effect

	CIT	DT	CGT	DT&CGT	LIT
Aggregate	$0.67	$1.56	-$0.28	$0.50	$0.22
Retired	$0.07	$0.03	$0.06	$0.04	-$0.81
Working	$0.77	$1.55	-$0.07	$0.61	$0.14
Future	$0.70	$1.96	-$0.59	$0.50	$0.58
Low skill	$0.03	$0.55	-$0.53	-$0.07	-$0.26
Medium skill	$0.52	$1.30	-$0.32	$0.37	$0.08
High skill	$1.35	$2.67	-$0.06	$1.10	$0.77

Table: MEB by skill and age group

Model features and marginal excess burden (MEB)

Model	CIT	DT	CGT	DT&CGT	LIT
Benchmark	$0.67	$1.56	-$0.28	$0.50	$0.22
Neoclassical	$0.79	$0.80	$0.77	$0.79	$0.26

Table: MEB of raising 1 dollar revenue in NPV terms in different models

▶ Benchmark model: Heterogeneous firms, life-cycle households, financing constraint, and DRS technology

▶ Neoclassical model: Representative firm, representative household, and CRS technology

Related literature

- Tax incidence:
  - Classic work: Harberger (1962) and Fullerton and Metcalf (2002) for a survey
  - Recent development: Sachs, Tsyvinski and Werquin (2019), Saez and Zucman (2019) and Tran and Wende (2017)

- Capital income taxation:
  - Zero capital tax: Judd (1985), Chamley (1986)
  - Positive capital tax: Hubbard and Judd (1986), Erosa and Gervais (2002), Aiyagari (1995), Imrohoroglu (1998) and Conesa, Krueger and Kitao (2009)

- Capital taxes, investment and aggregates
  - Corporate income taxes: McGrattan and Prescott (2005), Santoro and Wei (2011) and Anagnostopoulos, Carceles-Poveda and Lin (2012) , Anagnostopoulos, Carceles-Poveda and Lin (2012)
  - Dividend and capital gains taxes: Gourio and Miao (2010) and Gourio and Miao (2011)
  - Firm heterogeneity and corporate taxes: Anagnostopoulos, Atesagaoglu and Carceles-Poveda (2015) and Wills and Camilo

Model

The model: Overview
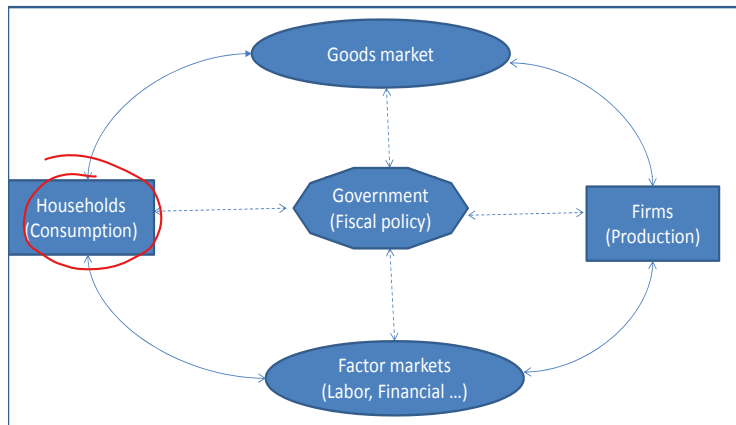
An incomplete market model with heterogeneous agents

- ▶ Dynamic stochastic general equilibrium (DSGE) model

- ▶ Overlapping generations of life-cycle households as in Auerbach and Kotlikoff (1987) with skill heterogeneity and borrowing constraints.

- ▶ Heterogeneous firms as in Gourio and Miao (2010) with idiosyncratic productivity shocks, financing constraints and financial policy

- ▶ Calibrated to the US data in early 2010s

Households I

- Demographics: 20 to 100 years
- Preferences: Households value consumption and leisure and maximize the discounted lifetime utility
- Endowments: Newborns with different skills that define the life-cycle profiles of labor efficiency units

- A household begins with zero assets and chooses consumption, labor supply and asset holdings to maximise its utility over its lifetime.
- Saving technology: equity, $\theta_{i,j,t}$, and bonds, $B_{i,j,t}$, but can not short sell equity or debt $\theta_{t,j,i} \geq 0$, $B_{t,j,i} \geq 0$.
- Income sources: labor income, dividends, $d_t(\mu_t)$, capital gains, interest payments, accidental bequests, $BQ_{t,i}$, and government transfers $T_{t,j,i}$.

Households II

- Taxes: Consumption tax, labor income tax, and taxes on dividends, capital gains and interest income with rates τ^l, τ^d, τ^g and τ^i respectively.

- The household problem is given by

$$U = \sum_{j=20}^{100} S_j \beta^j \frac{\left(c_j^\gamma l_j^{1-\gamma}\right)^{1-\sigma}}{1-\sigma}$$

subject to

next asset holding

$$(1+\tau^c)C_j + \int p_t \theta_{j+1} d\mu_t + B_{j+1}$$
$$= (1-\tau^l)W_t(1-l_t)e_j + (1+(1-\tau^i)r_t))B_j + T_j + BQ_j$$
$$+ \int \left(p_t^0 + (1-\tau^d)d_t - \tau^g\left(p_t^0 - p_{t-1}\right)\right)\theta_j d\mu_{t-1}.$$

Simplified household problem I

- No arbitrage condition implies

$$(1 - \tau^i) r_{t+1} = \frac{E_t \left[(1 - \tau^d) d_{t+1} + (1 - \tau^g)(p_{t+1}^0 - p_t) \right]}{p_t}$$

- Assuming that households hold similar an equal share of each firm, so that we can express asset portfolios in terms of the representative asset

$$A_{t+1,j+1,i} = \left(\int p_t \theta_{t+1,j+1,i} d\mu_t + B_{t+1} \right)$$

and the return on the asset, r_t^a, is given by

$$r_t^a = \frac{(1 - \tau^i) r_t B_t + \int \left[(1 - \tau^d) d_t + (1 - \tau^g)(p_t - p_{t-1}) \right] d\mu_{t-1}}{B_t + \int p_{t-1} d\mu_{t-1}}.$$

- The household's budget constraint can be re-written as

$$(1 - \tau^c) C_{t,j,i} + A_{t+1,j+1,i} = (1 - \tau^l) W_t (1 - l_{t,j,i}) e_{j,i} + (1 + r_t^a) A_{t,j,i}$$
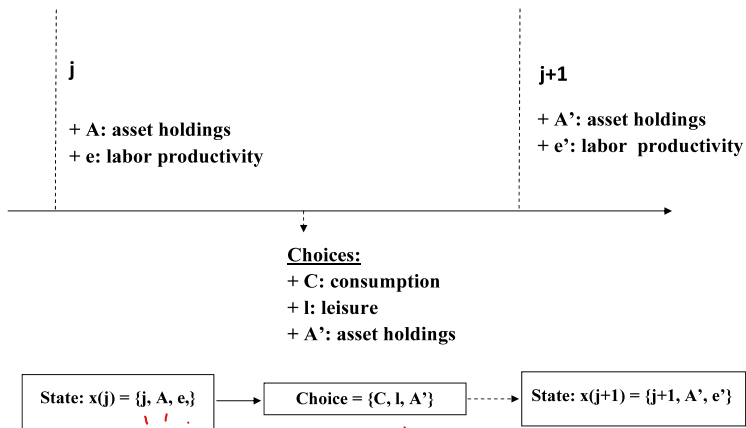$$+ T_{t,j,i} + BQ_{t,i}.$$

Simplified household problem II

▶ The household's dynamic programming problem is given by

$$V_j(A_{t,j,i}) = \max_{\{C_{t,j,i}, l_{t,j,i}, A_{t+1,j+1,i}\}} \left\{ u\left(C_{t,j,i}, l_{t,j,i}\right) + \hat{\beta} sp_{j+1} V_{j+1}\left(A_{t+1,j+1,i}\right) \right\}$$

subject to the household's budget constraint, the credit constraint, $A_{t+1,j+1,i} \geq 0$, and the non-negativity of leisure and consumption $C_{t,j,i} > 0$ and $1 \geq l_{t,j,i} > 0$.

Timing of household decision

j

+ A: asset holdings
+ e: labor productivity

j+1

+ A': asset holdings
+ e': labor productivity

<u>Choices:</u>
+ C: consumption
+ l: leisure
+ A': asset holdings

State: x(j) = {j, A, e,} → Choice = {C, l, A'} ⇢ State: x(j+1) = {j+1, A', e'}

Firms

- The production sector consists of a continuum of ex-ante identical firms exposed idiosyncratic productivity shocks.

- The firms own capital and chooses investment, dividends, equity and labor demand to maximize their cum dividend equity price.

  corporate Finance

- Firms differ ex-post in terms of the histories of productivity shocks and capital stock.

Technology

▶ Production function

$$F(k, n; z) = zk^{\alpha_k} n^{\alpha_n}$$

where $\alpha_k + \alpha_l < 1$ (DRS)

▶ Productivity evolves according to

$$\ln z_t = \rho \ln z_{t-1} + \epsilon_t$$

where ϵ_t IID $\mathcal{N}(0, \sigma^2)$

▶ Capital accumulation

$$k_t = (1 - \delta)k_{t-1} + i_t$$

▶ Investment cost

$$C(i) = i + \frac{\psi i^2}{2k}$$

▶ Earnings after wages

$$\pi = zk^{\alpha_k} n^{\alpha_n} - wn$$

Corporate finance I

- The firm is owned by equity holders who receive a return on equity by receiving dividends d_t, and also capital gains on changes in the equity price.

- Investment finance: Internal finance from earnings after wages and taxes and external finance by issuing new equity, s_t.

- Non-negative dividends constraint

$$d_t \geq 0.$$

- Equity buy-backs constraint

$$s_t \geq -\bar{s}$$

- No dividend payout unless the firm is fully utilising its ability to pay out returns through the buy-backs giving the constraint

$$d_t(s_t + \bar{s}) = 0.$$

Corporate finance II

▶ The value of a firm's equity after issuance is given by the pre-issuance value plus the value of issuance

$$p_t = s_t + p_t^0.$$

▶ The firm pays corporate income tax on its income which is revenue minus wages $\tau^k \left(zk^{\alpha_k} n^{\alpha_n} - w_t n_t \right)$.

▶ The firm can also deduct from its taxable income a fraction of its investment and capital depreciation.

▶ Using the households' first order condition for equity yields

$$(1 - \tau^i) r_{t+1} = \frac{E_t \left[(1 - \tau^d) d_{t+1} - (1 - \tau^g) s_{t+1} + (1 - \tau^g)(p_{t+1} - p_t) \right]}{p_t}.$$

Corporate finance III

▶ The no arbitrage condition for the fair price of equity is given by

$$p_t = \frac{E_t \left[(1-\tau^d)/(1-\tau^g)d_{t+1} + p_{t+1} - s_{t+1}\right]}{1 + r^i_{t+1}/(1-\tau^g)}.$$

Here $r^i_t = (1-\tau^i)r_t$ is the after tax interest rate.

Timing of firm decision

t

+ k: capital
+ z: productivity

t+1

+ k': capital
+ z': productivity

Firm's decision:
+ labor: n
+ investment: i and k'
+ financing: d and s

| Firm's value: V{k, z} | Choice = {n, i, k', d, s} | Firm's value: V{k', z'} |
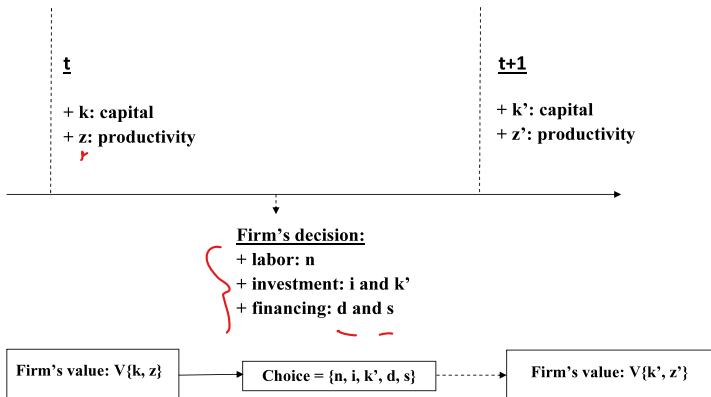
Firm problem I

▶ Each firm maximises its cum dividend value which is defined as

$$V_t = \frac{1-\tau^d}{1-\tau^g} d_t - s_t + p_t$$

▶ The firms problem can be written as

$$V_t(k_t, z_t) = \max_{d_t, s_t, i_t, n_t, k_{t+1}} \frac{1-\tau^d}{1-\tau^g} d_t - s_t + \frac{E_t\left[V_{t+1}(k_{t+1}, z_{t+1})\right]}{1 + r_{t+1}^i/(1-\tau^g)}$$

s.t.

$$i_t + \frac{\psi i_t^2}{2k_t} + d_t = (1-\tau^k)(z_t k_t^{\alpha_k} n_t^{\alpha_n} - w_t n_t) + \tau^k \delta k_t + s_t,$$

$$k_{t+1} = (1-\delta)k_t + i_t$$

$$d_t \geq 0 \ , \ s_t \geq -\bar{s} \ , \ d_t(\ s_t + \bar{s}) = 0.$$

Government

▶ The government collects taxes to finance government consumption and transfers. The government budget is given by

$$B_{t+1} = TAX_t - G_t - T_t - (1 + r_t) B_t.$$

▶ B_{t+1} is new government debt issued at time t and B_t outstanding government debt issued at time $t - 1$.

Calibration

Benchmark calibration

- To match the US economy in early 2010s
- Macroeconomic aggregate data
- Firm level data from COMPUSTAT

Calibration value

	Parameter	Value
Exponent on capital	α_k	0.311
Exponent on labor	α_l	0.650
Shock persistence	ρ	0.767
Shock standard deviation	σ	0.211
Depreciation rate	δ	0.095
Adjustment cost	ψ	0.890
Equity buy-back constraint	$\bar{s}$	0.085
Discount factor	β	0.983
Consumption share	γ	0.25
Inter-temporal elasticity	$1/\sigma$	0.4
Corporate income tax	τ^k	0.340
Dividend tax	τ^d	0.200
Capital gains tax	τ^g	0.200
Interest income tax	τ^i	0.250
labor income tax	τ^n	0.240
Consumption tax	τ^n	0.025
Deductibility of depreciation	χ^δ	1.00
Deductibility of investment	χ^I	0.00

Table: Model Calibrations

Household: Labor productivity
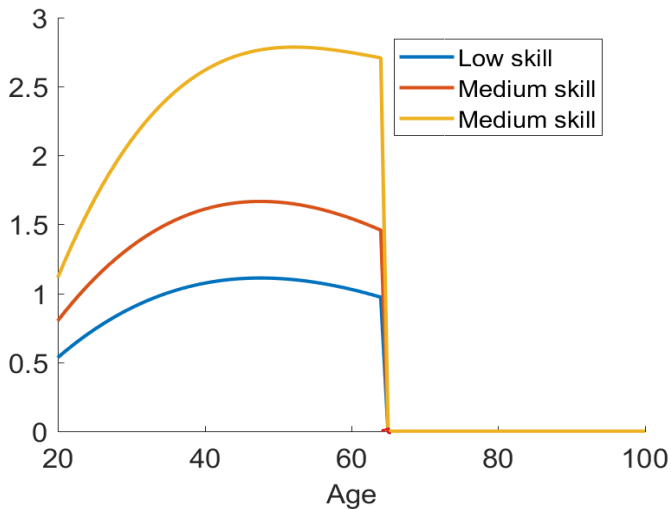
Firm: Productivity

$z =$	0.36	0.47	0.59	0.73	0.90	1.11	1.36	1.69	2.13	2.79
	0.31	0.46	0.20	0.03	0.00	0.00	0.00	0.00	0.00	0.00
	0.06	0.33	0.40	0.17	0.03	0.00	0.00	0.00	0.00	0.00
	0.01	0.11	0.35	0.36	0.14	0.02	0.00	0.00	0.00	0.00
	0.00	0.02	0.17	0.37	0.32	0.11	0.01	0.00	0.00	0.00
$\pi =$	0.00	0.00	0.04	0.22	0.39	0.27	0.07	0.01	0.00	0.00
	0.00	0.00	0.01	0.07	0.27	0.39	0.22	0.04	0.00	0.00
	0.00	0.00	0.00	0.01	0.11	0.32	0.37	0.17	0.02	0.00
	0.00	0.00	0.00	0.00	0.02	0.14	0.36	0.35	0.11	0.01
	0.00	0.00	0.00	0.00	0.00	0.03	0.17	0.40	0.33	0.06
	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.20	0.46	0.31

Table: Productivity levels and transition matrix

Firm: Equity issuance or dividend distribution

MPK: high.

$\boxed{MPK = \text{Same}}$

Ext. Finance

1

2

3

DT

MPK: small

> 0

0

$d = 0$
$S > 0$

$d = 0$
$S = 0$

$d > 0$
$S < 0$

size

< 0
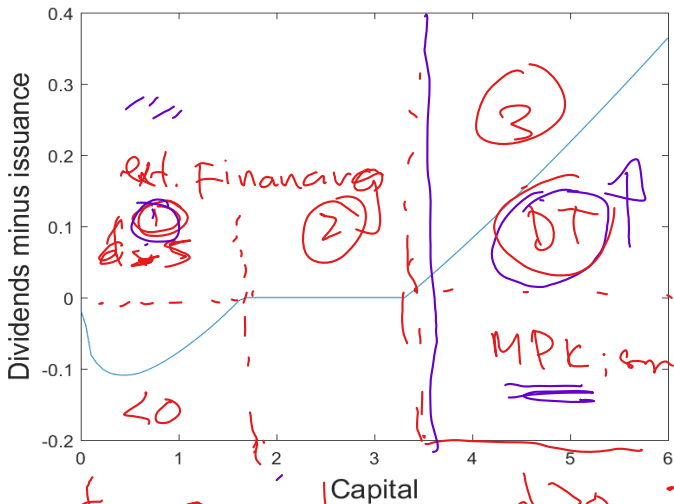
Capital

Firm: Net investment by capital level
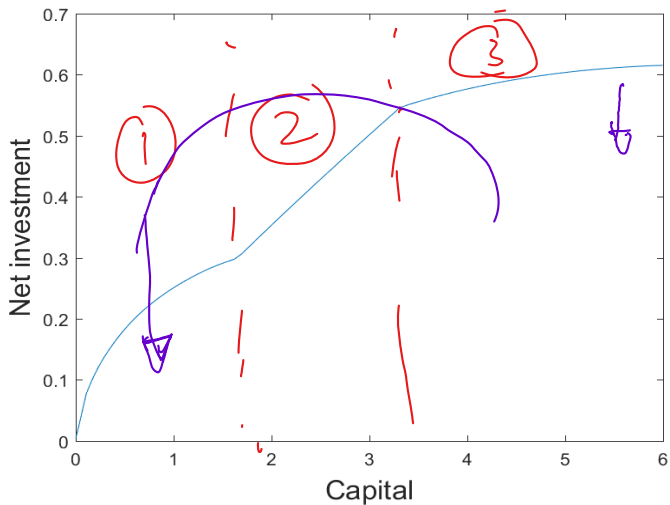
Marginal excess burden analysis

Experiments: Marginal excess burden analysis

▶ Raise 1 dollar of net tax revenue (in NPV terms) in each future period

▶ Compute the welfare costs of such tax increase
  ▶ Using equivalent variation (EV) as a measure of the welfare costs

▶ Compute marginal excess burden (MEB) =(Marginal change in welfare)/(Marginal change in tax revenue)

▶ Taxes: Corporate income tax (CIT), dividend tax (DT), capital gains tax (CGT) and labor income tax (LIT)

Harberger's triangle and marginal excess burden (MEB)

Figure: Marginal excess burden of a tax increases

- MEB = Δ welfare / Δ revenue= (C+D+E)/(A+B-D).

Efficiency effect: Marginal excess burden (MEB)

DT > CIT

Model	CIT	DT	CGT	DT&CGT	LIT
Benchmark	$0.67	$1.56	-$0.28	$0.50	$0.22

Table: Marginal excess burden of raising 1 dollar revenue in NPV terms

- ► CIT: Corporate income tax;
- ► DT: Dividend tax;
- ► CGT: Capital gain tax;
- ► LIT: Labor income tax

-28 cents

Corporate tax increase

Corporate income tax (CIT): Output
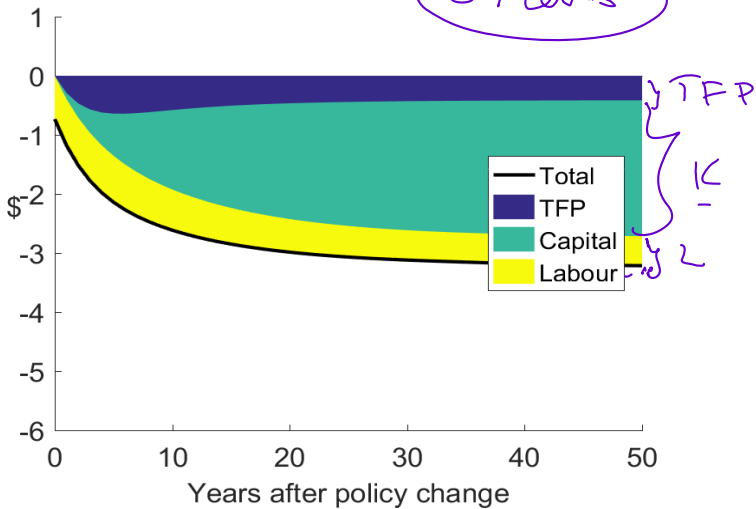
Corporate income tax (CIT): Capital by level of firm productivity
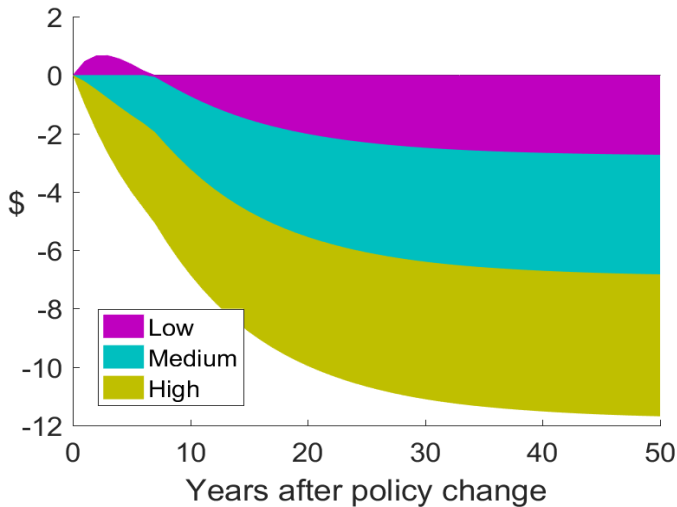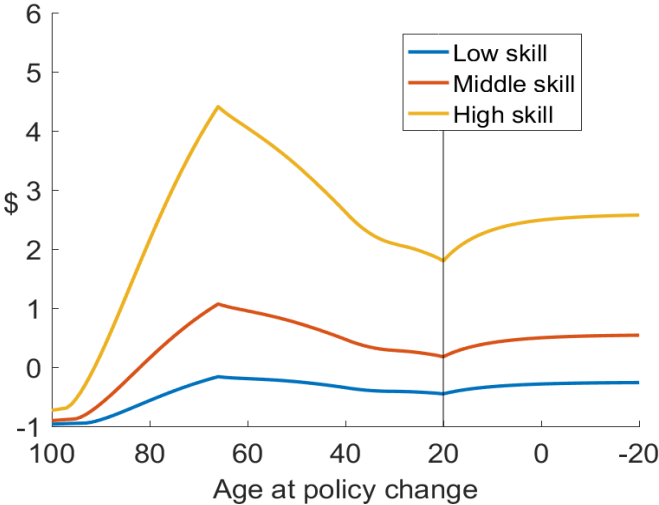
Corporate income tax (CIT): Labor income
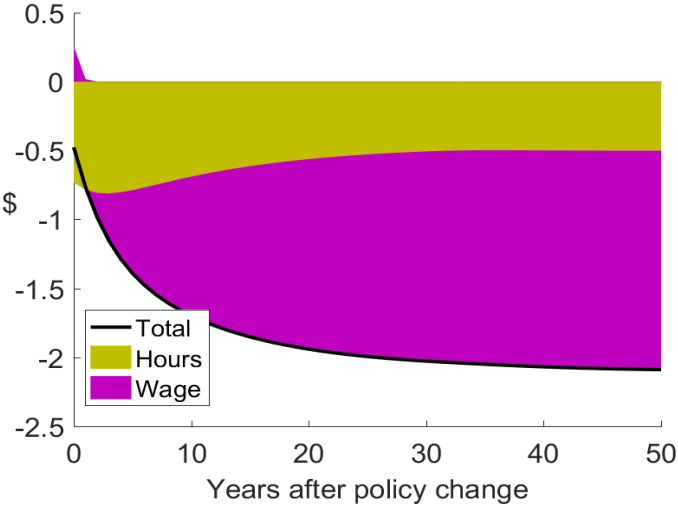
Corporate income tax (CIT): Assets
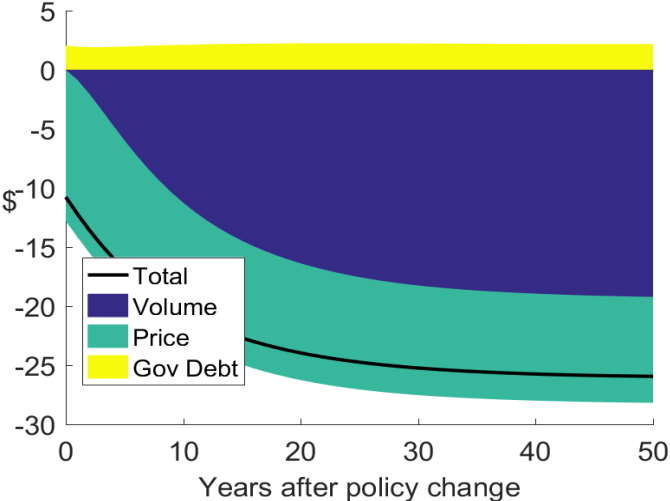
Corporate income tax (CIT): Revenue
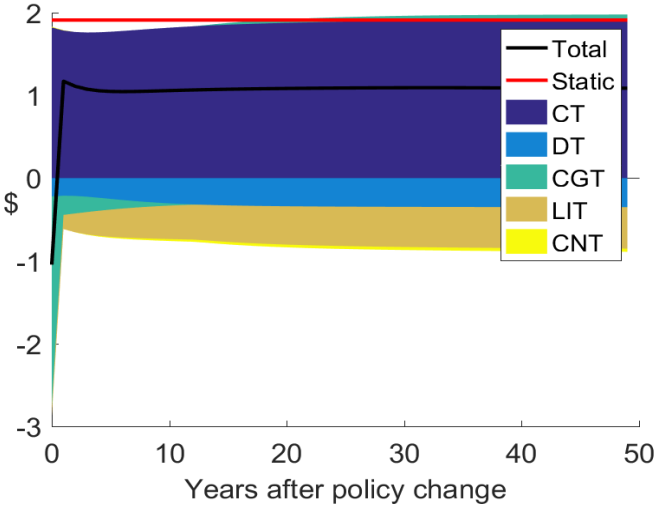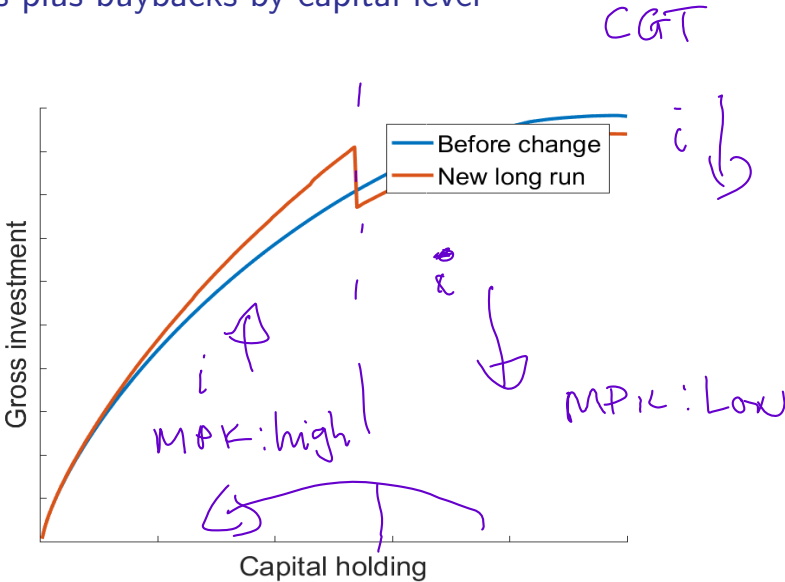
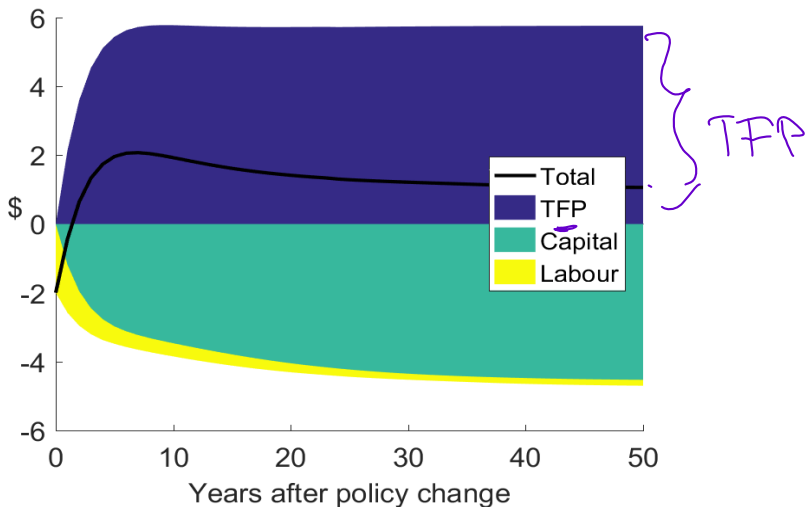# Corporate income tax (CIT): Welfare change

Capital gains tax increase

CGT

Dividends plus buybacks by capital level

Gross investment (y-axis) vs Capital holding (x-axis)

Legend:
- Before change
- New long run

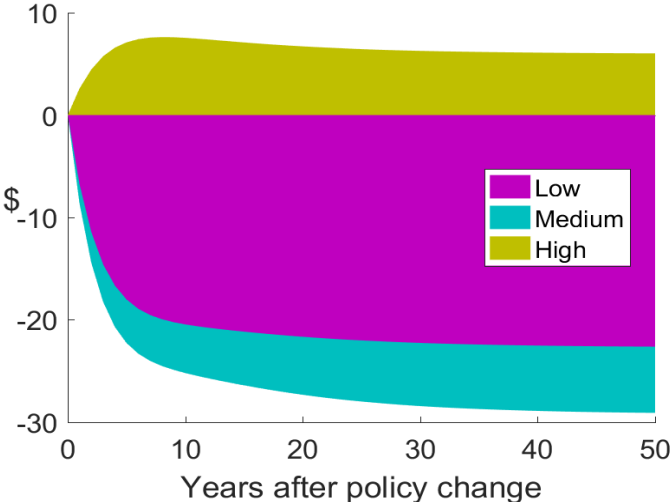Handwritten annotations: CGT, i ↓, MPK: high, i ↑, MPK: Low

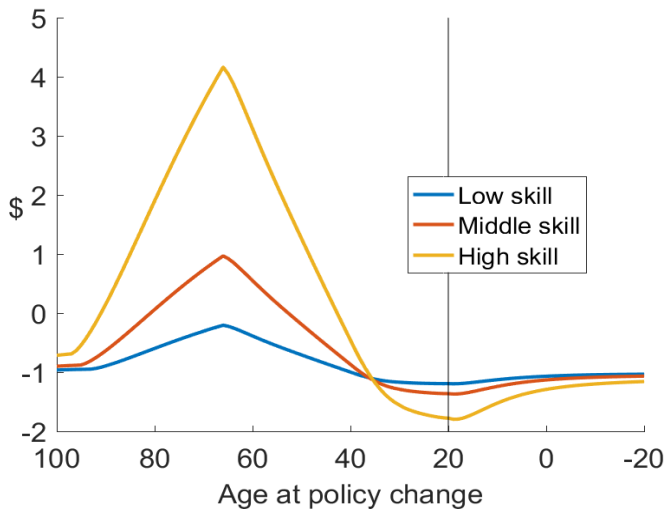# Capital gains tax: Output

$$TFP = Y / (K^{\alpha_K} N^{\alpha_N})$$
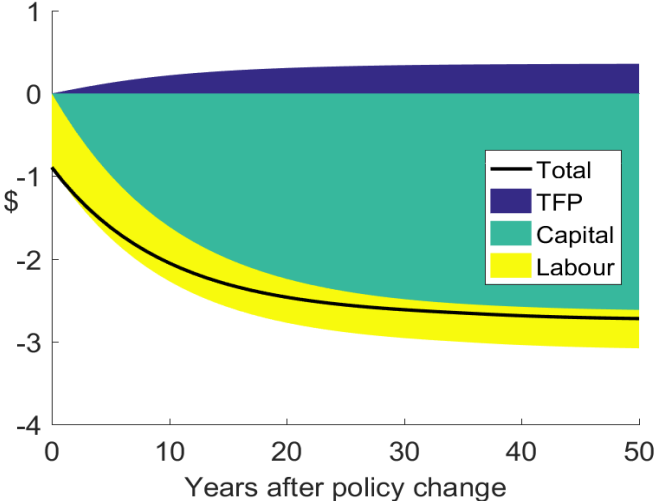
Capital gains tax: Capital by level of firm productivity
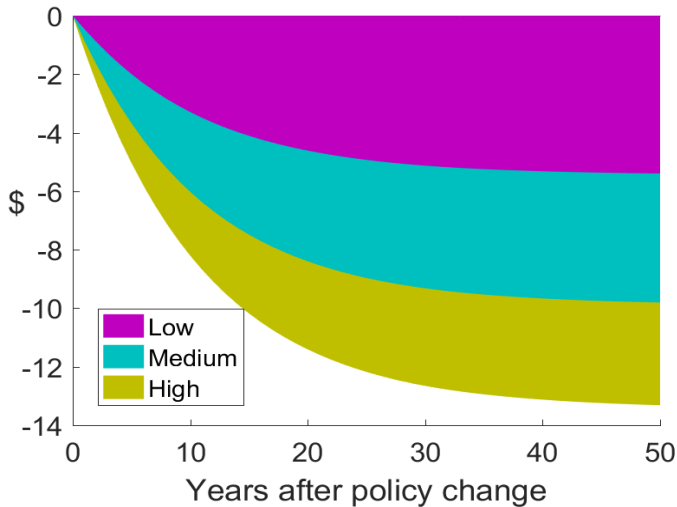
Capital gains tax: Welfare change

Dividend and capital gains tax increase

Dividend and capital gains taxes: Output

Dividend and capital gains taxes: Capital by productivity

Distributive effect: MEB by age and skill

	CIT	DT	CGT	DT&CGT	LIT
Aggregate	$0.67	$1.56	-$0.28	$0.50	$0.22
Retired	$0.07	$0.03	$0.06	$0.04	-$0.81
Working	$0.77	$1.55	-$0.07	$0.61	$0.14
Future	$0.70	$1.96	-$0.59	$0.50	$0.58
Low skill	$0.03	$0.55	-$0.53	-$0.07	-$0.26
Medium skill	$0.52	$1.30	-$0.32	$0.37	$0.08
High skill	$1.35	$2.67	-$0.06	$1.10	$0.77

Table: MEB by skill and age group

Model features and MEB

Model features

- ► Our benchmark model
  - ► Heterogeneous firms w/ different productivity shocks and investment finance regimes
  - ► Heterogeneous lifecycle households w/ different ages and skills
  - ► DRS technology

- ► How important are these features?

- ► Considering a range of different models:
  1. Model A: Rep. firm, lifecycle households, internal finance, DRS
  2. Model B: Rep. firm, lifecycle households, external finance, DRS
  3. Model C: Heterogeneous firms, rep. household, DRS
  4. Model D: Rep. firm, rep. household, external finance, DRS
  5. Model E: Rep. firm, rep. household, CRS technology (Neoclassical model)

Marginal excess burden: Model comparison

misallocation

Model	CIT	DT	CGT	D&CGT	LIT
0. Bench. Model	$0.67	$1.56	-$0.28	$0.50	$0.22
1. Mod. A: H HH, R firm, IF	$0.54	$0.13	$1.43	$0.52	$0.24
2. Mod. B: H HH, R firm, EF	$0.54	$0.66	$0.22	$0.52	$0.24
3. Mod. C: R HH, H firm	$0.71	$1.95	-$0.36	$0.52	$0.22
4. Mod. D: R HH, R Firm, IF	$0.58	$0.75	$1.21	$0.48	$0.16
5. Mod. E: R HH, R Firm, EF, CRS	$0.79	$0.80	$0.77	$0.79	$0.26

Table: Marginal excess burden

$\tau^k = \boxed{36\%}$?

Efficiency and distributive effects of taxes: Model features

- ▶ Household heterogeneity introduces distributional consequences
  - ▶ Model 0 and Models A and B with heterogeneous households
- ▶ Firm heterogeneity introduces a new channel of efficiency effects
  - ▶ Misallocation channel
  - ▶ Model 0 and Model C with heterogeneous firms

Firm heterogeneity and misallocation channel

- ▶ Productivity and capital levels
    - ▶ Technology shocks
    - ▶ Investment and capital accumulation
    - ▶ Age of firms
- ▶ Investment finance
    - ▶ Internal financing through retained profits
    - ▶ External financing through equity issuance

- ▶ Different capital taxes affect firms differently.

- ▶ Tax distortions and financial constraints lead to inefficient allocation of capital across firms.

Tax reforms

Corporate tax reforms

- ▶ Principle: Move away from taxes w/ high MEB
- ▶ Action: Cut taxes on corporate income (Firm): CIT cuts

- ▶ Shift tax burden to personal income (Household)
  1. Dividend tax
  2. Dividend and capital gains taxes
  3. Labor income tax

- ▶ Outcome: Efficiency and distributive effects

Reform 1: The CIT cuts financed by dividend tax

CIT rate (%)	0	8	16	24	32
Output change (%)	-	-	0.5	-0.3	-0.4
Welfare change (%)	-	-	-1.98	-1.42	-0.35
Retired welfare Δ (%)	-	-	-5.46	-2.86	-0.26
Working welfare Δ (%)	-	-	-2.49	-1.6	-0.33
Future welfare Δ (%)	-	-	-0.3	-0.76	-0.39
Low skill Δ (%)	-	-	-1.6	-1.23	-0.34
Medium skill Δ (%)	-	-	-1.9	-1.39	-0.35
High Skill Δ (%)	-	-	-2.15	-1.51	-0.36
Population support (%)	-	-	0	0	0
τ^d (%)	-	-	73.8	53.9	26.3

Table: The welfare effects of the CIT cuts financed by dividend tax.

# Reform 2: The CIT cuts financed by dividend and capital gains taxes

CIT rate (%)	0	8	16	24	32
Output change (%)	0.9	0.8	0.6	0.4	0.1
Welfare change (%)	0.22	0.29	0.29	0.22	0.06
Retired welfare Δ (%)	-0.34	-0.19	-0.07	0	0.01
Working welfare Δ (%)	0.16	0.23	0.24	0.19	0.05
Future welfare Δ (%)	0.32	0.38	0.37	0.27	0.07
Low skill Δ (%)	0.29	0.33	0.31	0.23	0.06
Medium skill Δ (%)	0.24	0.29	0.29	0.22	0.06
High Skill Δ (%)	0.19	0.27	0.28	0.21	0.06
Population support (%)	34	45	55	84	100
τ^d, τ^g (%)	53.4	47.8	41.1	33	22.9

Table: Impact of replacing corporate tax with dividend and capital gains tax.

Reform 3: The CIT cuts financed by labor income tax

CIT (%)	0	8	16	24	32
Output change (%)	2.2	1.9	1.5	0.9	0.2
Welfare change (%)	0.82	0.72	0.57	0.36	0.08
Retired welfare Δ (%)	10.35	8.1	5.74	3.26	0.67
Working welfare Δ (%)	1.39	1.2	0.94	0.59	0.13
Future welfare Δ (%)	-2.97	-2.03	-1.22	-0.56	-0.09
Low skill Δ (%)	-0.13	0	0.08	0.1	0.03
Medium skill Δ (%)	0.64	0.58	0.47	0.31	0.07
High Skill Δ (%)	1.25	1.04	0.78	0.48	0.11
Population support (%)	81	81	81	82	82
τ^n (%)	27.3	25.3	23.3	21.1	18.9

Table: The welfare effects of the corporate tax cuts financed by labor income tax.
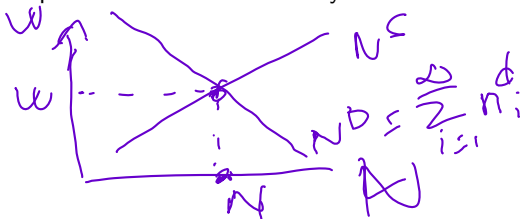
Conclusion

- The welfare costs of capital taxes are relatively large and allocated unevenly to households and generations

- The CIT cuts improve efficiency, but lead to different welfare outcomes.

- The important features are
  - Firm heterogeneity: Allocative inefficiency
  - Lifecycle structure: Saving and capital accumulation
  - Financing constraints: Investment and capital accumulation

Bibliography I

Aiyagari, Rao S. 1995. "Optimal Capital Income Taxation with Incomplete Markets, Borrowing Constraints,and Constant Discounting." *Journal of Political Economy* 103:1158–1175.

Anagnostopoulos, Alexis, Eva Carceles-Poveda and Danmo Lin. 2012. "Dividend and capital gains taxation under incomplete markets." *Journal of Monetary Economics* 59(7):599–611.

Anagnostopoulos, Alexis, Orhan Erem Atesagaoglu and Eva Carceles-Poveda. 2015. "On the Double Taxation of Corporate Profits." *Woprking paper* .
URL:
http://www.aueb.gr/conferences/Crete2014/papers/Anagnostopoulos.pdf

Auerbach, Alan J. and Laurence J. Kotlikoff. 1987. *Dynamic Fiscal Policy*. Cambridge Unversity Press.

Chamley, Christophe. 1986. "Optimal Taxation of capital Income in General Equilibrium with Infinite Lives." *Econometrica* 54(3):607–622.

Bibliography II

Erosa, Andres and Martin Gervais. 2002. "Optimal Taxation in Life-Cycle Economies." *Journal of Economic Theory* 105:338–369.

Fullerton, D. and G. E. Metcalf. 2002. "Tax incidence." *Handbook of Public Economics* 4:1787–1872.

Gourio, Francios and Jianjun Miao. 2010. "Firm Heterogeneity and the Long-run Effects of Dividend Tax Reform." *American Economic Journal: Macroeconomics* 2:1:131–168.

Gourio, Francios and Jianjun Miao. 2011. "Transitional dynamics of dividend and capital gains tax cuts." *Review of Economic Dynamics* 14:368–383.

Harberger, Arnold. 1962. "The incidence of the corporation income tax." *The Journal of Political Economy* 70 (3):215–240.

Hubbard, Glenn R. and Kenneth L. Judd. 1986. "Liquidity Constraints, Fiscal Policy, and Consumption." *Brookings Papers on Economic Activity* pp. 1–50.

Bibliography III

Imrohoroglu, Selahattin. 1998. "A Quantitative Analysis of Capital Income Taxation." *International Economic Review* 39:307–328.

Judd, Kenneth L. 1985. "Redistributive Taxation in a Simple Perfect Foresight Model." *Journal of Public Economics* 28:59–83.

McGrattan, Ellen and Edward Prescott. 2005. "Taxes, Regulations and the Value of U.S. Corporations." *Federal Reserve Bank of Minneapolis, Research Department Staff Report* .

Sachs, Dominik, Aleh Tsyvinski and Nicolas Werquin. 2019. "Nonlinear Tax Incidence and Optimal Taxation in General Equilibrium." *Working Paper* .

Saez, Emmanuel and Gabriel Zucman. 2019. "Clarifying Distributional Tax Incidence: Who Pays Current Taxes vs. Tax Reform Analysis." *Working Paper* .

Santoro, Marika and Chao Wei. 2011. "Taxation, Investment and Asset Pricing." *Review of Economic Dynamics* 14(3):443–454.

Bibliography IV

Tran, Chung and Sebastian Wende. 2017. "On the Excess Burden of Taxation in an Overlapping Generations Economy." *ANU Working Paper* .

Wills, Daniel and Gustavo Camilo. 2017. "Taxing Firms Facing Financial Frictions." *Working Paper* .

Competitive equilibrium I

Given the transition probability matrices and the exogenous government policies, a competitive equilibrium is a collection of sequences of distributions of household decisions, aggregate capital stocks of physical and human capital, and market prices such that

▶ Households solve the consumer problem;

▶ Firms solve the firm problem and the F.O.Cs of firms hold;

▶ All markets clear and the general budget clear;

▶ The distribution is stationary;

▶ The aggregate resource constraint is given by

$$C_t + I_t + \Psi_t = Y_t$$

where

$$Y = \int y(k, z; w)\mu(dk, dz), \qquad L = \int l(k, z; w)\mu(dk, dz)$$

Competitive equilibrium II

$$I = \int i(k, z; w)\mu(dk, dz), \qquad \Psi = \int \frac{\psi i(k, z; w)^2}{2k}\mu(dk, dz)$$

$$p^T = \int p(k, z; w)\mu(dk, dz), \qquad d^T = \int d(k, z; w)\mu(dk, dz)$$
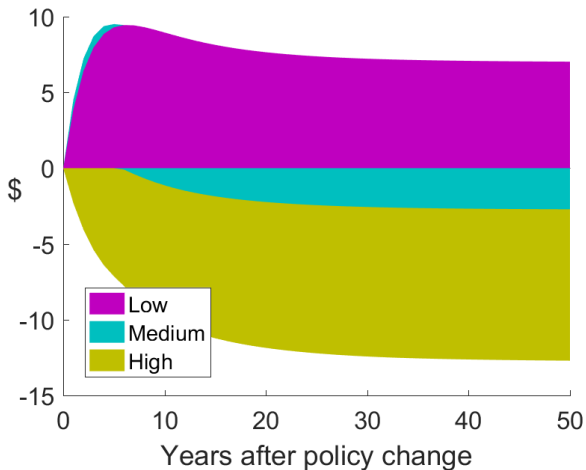
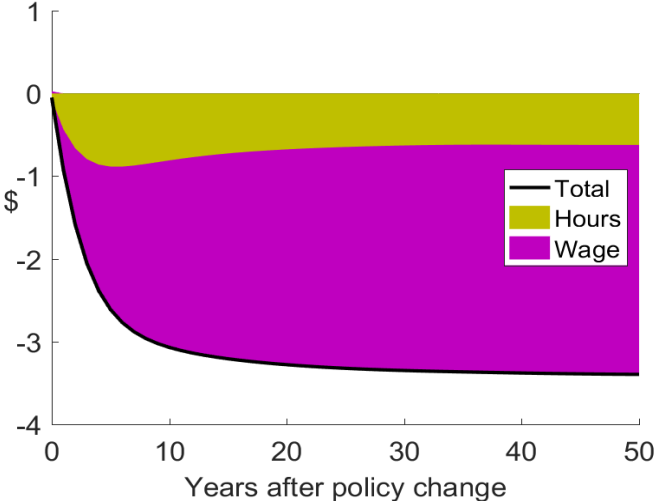$$s^T = \int s(k, z; w)\mu(dk, dz)$$

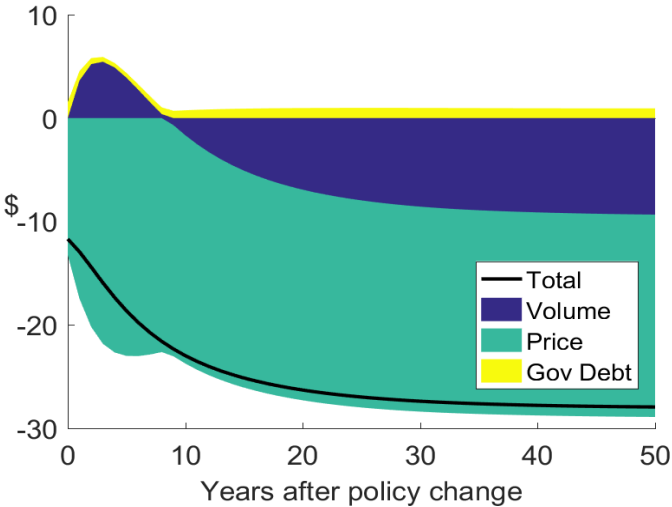# Dividend tax increase

Dividend tax: Output
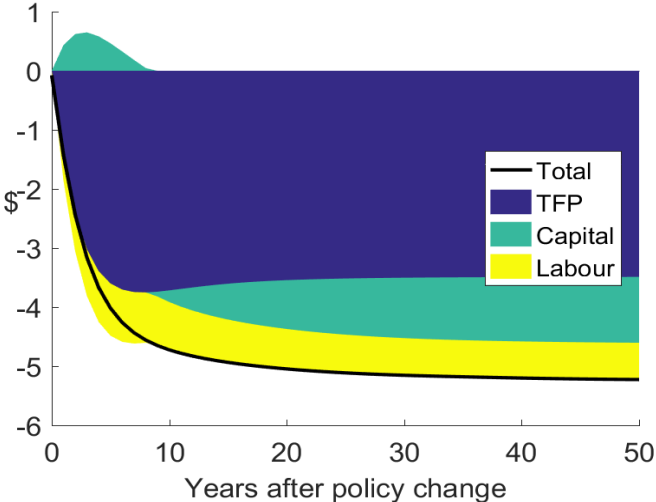
Dividend tax: Capital by level of firm productivity
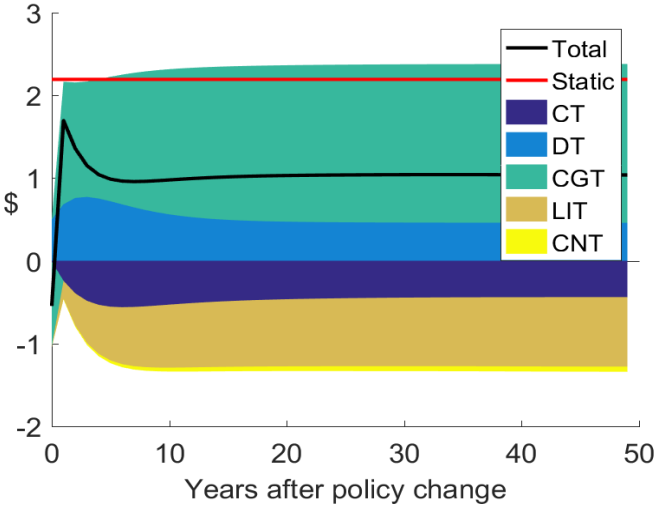
Dividend tax: Labor income

Dividend tax: Assets

Dividend tax: Revenue

Dividend tax: Welfare change