On the Distributional Effects of International Tariffs

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Introduction

- What are the distributional consequences of bilateral tariff increases?
  - Effect on labor markets: Autor, Dorn, Hanson, and Song (2014)
    - Low-skilled harmed more from opening to trade
  - Effect on prices: Fajgelbaum and Khandelwal (2016); Carroll and Hur (2019a)
    - Poor most sensitive to tradable consumption prices
    - Tradables are an input into production of capital: cost of investment; savers and dissavers

What we do

- Build a Ricardian trade model with
  - non-homothetic preferences
  - uninsurable income risk
  - segmented labor markets
  - distortionary labor and capital income taxes
- Study the distributional effects of tariffs under 4 cases
  - wasteful government spending
  - reduce labor income tax
  - reduce capital income tax
  - lump-sum redistribution

What we find

- What are the distributional consequences of bilateral tariff increases?
- Answer: It depends on how tariff revenue is distributed
- Without redistribution . . .
  - large welfare losses for everyone, but especially hurts the poor and the skilled
- With redistribution . . .
  - labor income tax reduction generates a more equitable distribution of welfare losses
  - capital income tax reduction strongly favors the rich (really hurts the poor)
  - lump-sum rebating tariff revenue can produce a welfare gain on average, but at the expense of the skilled

Model

Main ingredients of model

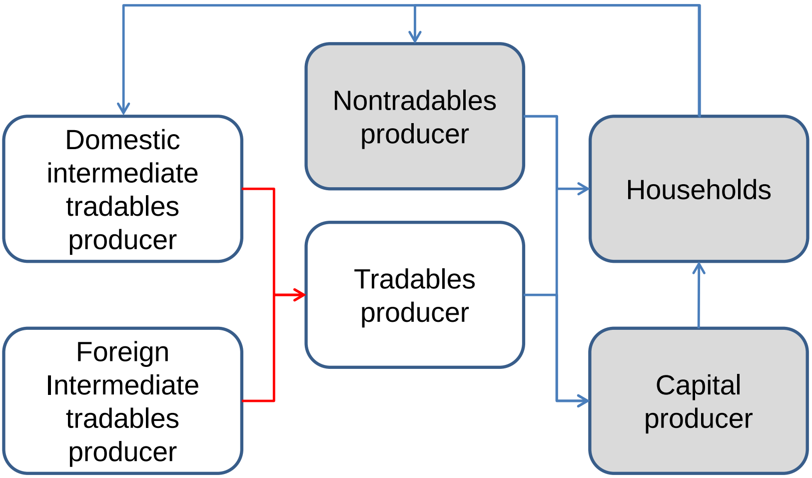
- Ricardian model of trade (Dornbusch-Fisher-Samuelson 1977)
- Uninsurable labor income risk (Aiyagari-Bewley-Hugget-Imrohoroglu)
- Capital-skill complementarity
- Non-homothetic preferences (Stone-Geary)
- Linear labor and capital income taxes

Model

- Two symmetric countries indexed by $i = 1, 2$
- Households
  - consume, work, and save
  - 2 types: unskilled and skilled
  - face uninsurable labor income risk
- Production and Trade
  - tradables and non-tradables used for consumption and for investment
  - $\omega \in [0, 1]$ continuum of tradable intermediate goods
  - shipment of good ω from o to i faces trade costs τ_{oi}
  - τ_{oi} consists of a technological cost $\tau_{oi,T}$ and a tariff $\tau_{i,P}$
- Government taxes to finance wasteful spending

Outline of model

- We begin with the production of tradable goods



Final tradables producer

- A representative final tradables producer bundles the varieties of tradables $\{q_{oi}(\omega)\}_{\omega,o}$ into a final good, Y_{iT}, and solves

$$\max_{\{q_{oi}(\omega)\}_{\omega}} P_{iT} Y_{iT} - \int_0^1 \sum_{o=1,2} \left[\tau_{oi} p_o(\omega) q_{oi}(\omega)\right] d\omega$$

$$\text{s.t. } Y_{iT} = \left\{ \int_0^1 \left[\sum_{o=1,2} q_{oi}(\omega) \right]^{\rho} d\omega \right\}^{\frac{1}{\rho}}.$$

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$$\text{s.t. } Y_{iT} = \left\{ \int_0^1 \left[\sum_{o=1,2} q_{oi}(\omega) \right]^{\rho} d\omega \right\}^{\frac{1}{\rho}}.$$

- Solution: $q_{oi}(\omega) \leq \left(\frac{\tau_{oi} p_o(\omega)}{P_{iT}} \right)^{-\theta} Y_{iT}, = \text{ if } q_{oi}(\omega) > 0.$
- Price: $P_{iT} = \left[\int_0^1 \min_o \{\tau_{oi} p_o(\omega)\}^{1-\theta} d\omega \right]^{\frac{1}{1-\theta}}$ where $\theta = \frac{1}{1-\rho}$ is the elasticity of substitution across varieties.

Intermediate tradables producer

- Each intermediate firm produces a single tradable variety, ω
- Taking as given the price $p_i(\omega)$, it solves

$$\max_{h_i(\omega),l_i(\omega),k_i(\omega)} p_i(\omega)\, y_i(\omega) - w_{iH} h_i(\omega) - w_{iL} l_i(\omega) - r_i k_i(\omega)$$

$$\text{s.t. } y_i(\omega) = z_i(\omega)\, F\left(h_i(\omega), l_i(\omega), k_i(\omega)\right)$$

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$$\text{s.t. } y_i(\omega) = z_i(\omega)\,F\left(h_i(\omega), l_i(\omega), k_i(\omega)\right)$$

- Zero-profit price:

$$p_i(\omega) = \frac{1}{z_i(\omega)}$$

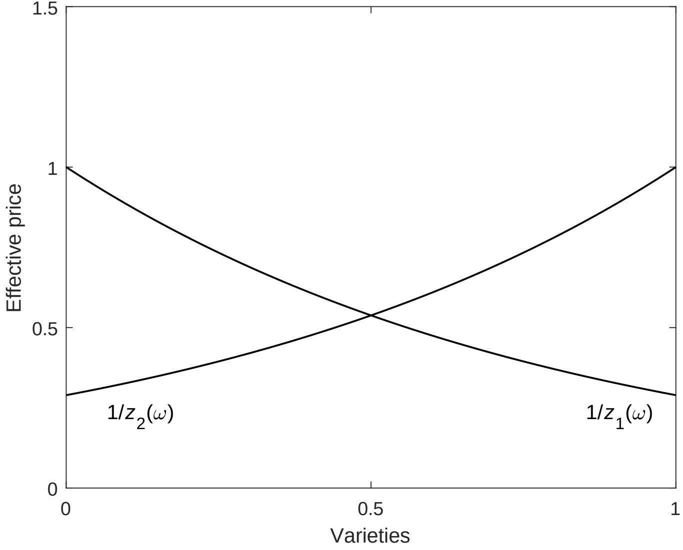
Productivity distributions in tradables production

- Productivities for variety ω are distributed according to

$$z_1(\omega) = e^{\eta\omega}$$
$$z_2(\omega) = e^{\eta(1-\omega)}$$

- Country $i = 1$ is more productive at producing high ω

Pattern of production (free trade)



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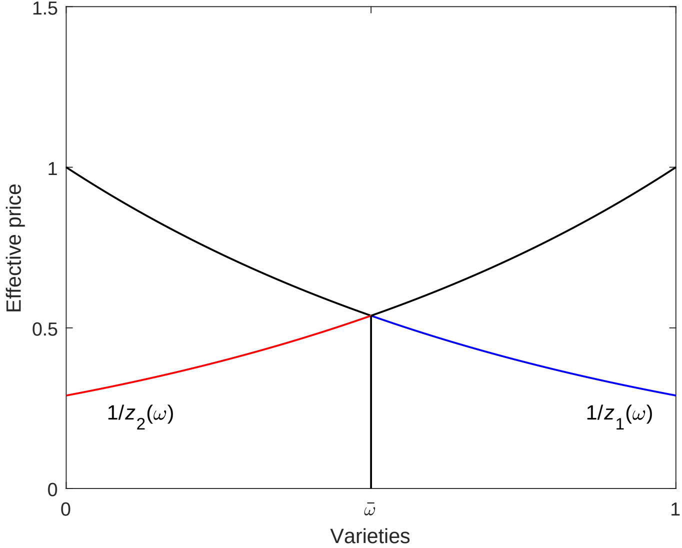
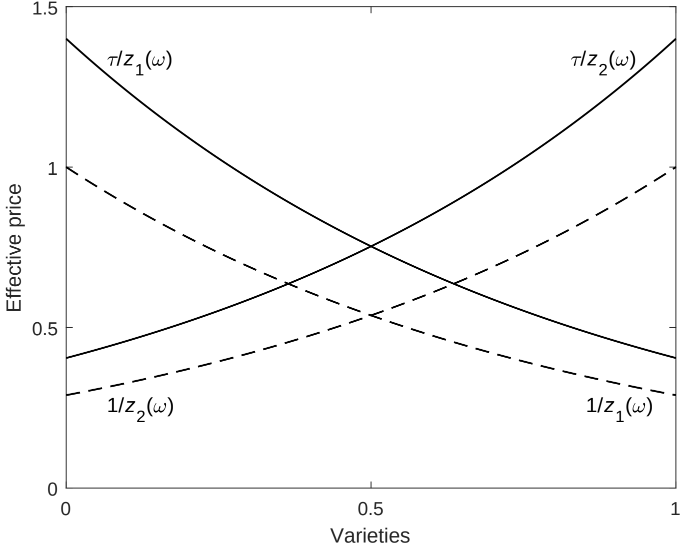


Pattern of production (costly trade)



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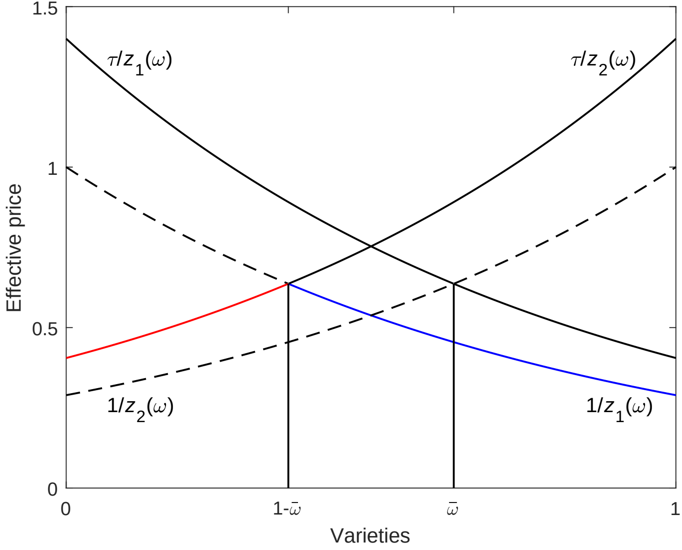

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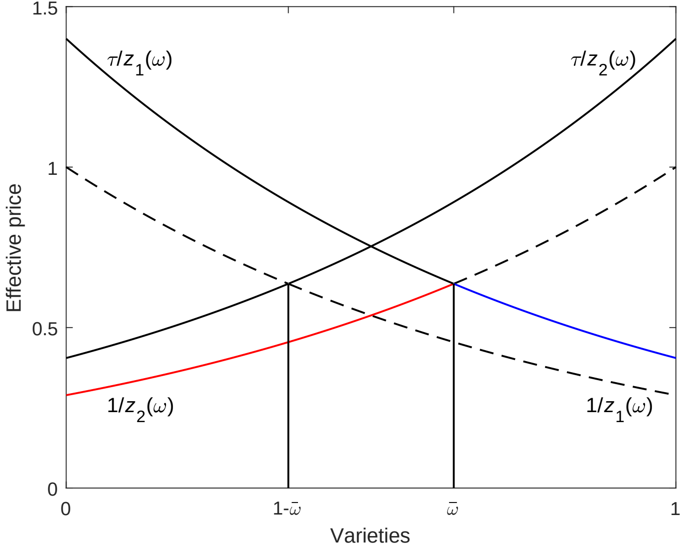
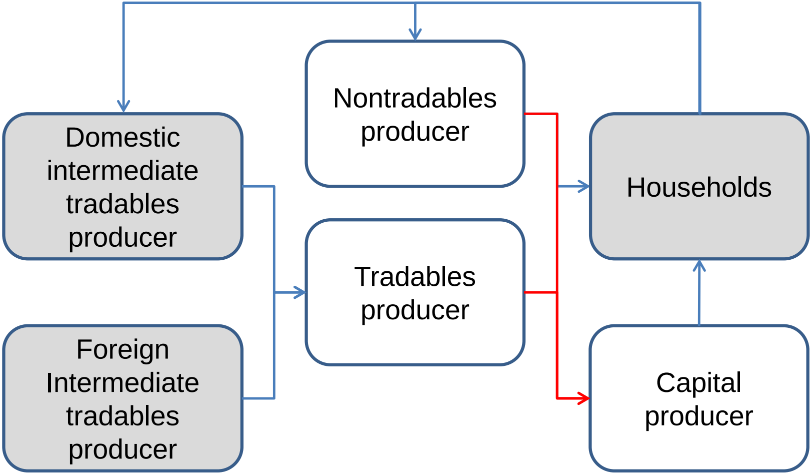


Outline of model

- Let's discuss the production of nontradable goods and capital



Non-tradables producer

- A representative firm produces non-tradable output Y_{iN}
- It solves the static profit maximization problem

$$\max_{H_{iN},L_{iN},K_{iN}} P_{iN}Y_{iN} - w_{iHi}H_{iN} - w_{iL}L_{iN} - r_i K_{iN}$$
$$\text{s.t. } Y_{iN} = z_{iN}F\left(H_{iN}, L_{iN}, K_{iN}\right).$$

- Numeraire: set $P_{iN} = 1$

Capital producer

- A representative firm produces capital X_i, by solving

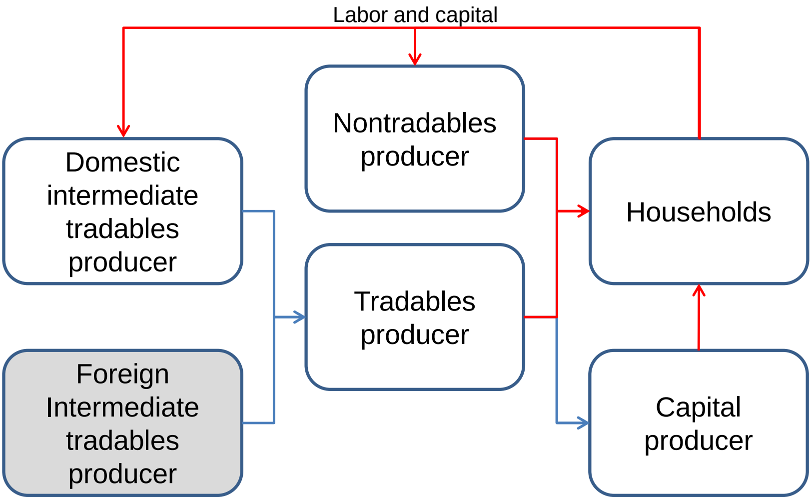
$$\max_{I_{iT}, I_{iN}} P_{iX} X_i - P_{iT} I_{iT} - I_{iN}$$
$$\text{s.t. } X_i = z_{iX} I_{iT}^{\kappa} I_{iN}^{1-\kappa}.$$

Government

- The government finances a constant stream of (wasteful) expenditures, G_i, by collecting
  - taxes on labor income, τ_{il},
  - taxes on capital income, τ_{ik},
  - and tariffs τ_{iP}

Outline of model

- Next, we discuss the household problem



Households

- Household with skill type, j, solves

$$V_{ij}(k,\varepsilon) = \max_{c_T, c_N, \ell, k'} u(c_T, c_N, \ell) + \beta E_{\varepsilon'|\varepsilon} V_{ij}(k', \varepsilon')$$

$$\text{s.t.} \quad P_{iT} c_T + c_N + P_{iX}(k' - k) \leq \tilde{w}_{ij} \ell \varepsilon + \tilde{r}_i k + T_i,$$

$$k' \geq 0$$

$$\text{where } u(c_T, c_N, \ell) = \frac{\left(c_T^{\gamma}(c_N + \bar{c})^{1-\gamma}\right)^{1-\sigma}}{1-\sigma} - \psi \frac{\ell^{1+\nu}}{1+\nu}$$

- $\tilde{w}_{ijt}$ and $\tilde{r}_{ijt}$ are after-tax returns:

$$\tilde{w}_{ij} = (1 - \tau_{il}) w_{ij}$$

$$\tilde{r}_i = (1 - \tau_{ik})(r_i - \delta P_{iX}).$$

Equilibrium

A *symmetric steady-state recursive equilibrium*, given fiscal policies $\{\tau_l, \tau_k, \tau_P, G, T\}$, is, for $j = H, L$

- Functions $\{V_j, g_{jT}, g_{jN}, g_{j\ell}, g_{jk}\}$,
- Nontradable producer plans $\{Y_N, H_N, L_N, K_N\}$,
- Final tradable producer plans $\left\{Y_T, \{q_{oi}(\omega)\}_{\omega\in[0,1], i=1,2, o=1,2}\right\}$,
- Intermediate producer plans $\{y_i(\omega), h_i(\omega), l_i(\omega), k_i(\omega)\}_{\omega,i}$,
- Capital producer plans $\{X, I_T, I_N\}$,
- Prices $\left\{w_H, w_L, r, P_T, P_X, \{p_i(\omega)\}_{\omega,i}\right\}$, and
- Invariant distributions $\{\mu_j^*\}_j$ such that:

1. Given prices, households optimize.
2. Given prices, firms optimize.
3. Goods markets clear.
4. Factor markets clear.
5. Balanced trade.
6. Gov't budget holds: $G + T = \tau_l \sum_j w_j \int \varepsilon g_{j\ell}(k,\varepsilon)\, d\mu_j(k,\varepsilon)$ $+\tau_k(r - \delta P_X)\sum_j \int k d\mu_j(k,\varepsilon) + \tau_P \int q_{oi}(\omega) d\omega$, for $o \neq i$.
7. For any $(\mathcal{K},\mathcal{E}) \in \mathcal{B}$, the invariant distribution μ_j^* satisfies

$$\mu_j^*(\mathcal{K},\mathcal{E}) = \int_S \sum_{\varepsilon' \in \mathcal{E}} 1_{\{g_{jk}(k,\varepsilon)\in\mathcal{K}\}} \Gamma(\varepsilon',\varepsilon)\, d\mu_j^*(k,\varepsilon).$$

Characterization of equilibrium

- The tradable price is given by $P_T = \dfrac{1}{\tilde{z}(\tau)}$,
  where $\tilde{z}(\tau)$ is a measure of aggregate productivity:
  $$\tilde{z}(\tau) = \left[\int_0^{1-\bar{\omega}(\tau)} \left(\frac{z_2(\omega)}{\tau}\right)^{\theta-1} d\omega + \int_{1-\bar{\omega}(\tau)}^{1} z_1(\omega)^{\theta-1}\, d\omega\right]^{\frac{1}{\theta-1}}$$
- Trade costs distort ...

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- Trade costs distort the extensive and intensive margins

Characterization of equilibrium

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- The capital price is given by $P_X = \frac{1}{z_X} \left(\frac{P_T}{\kappa} \right)^{\kappa} \left(\frac{1}{1-\kappa} \right)^{1-\kappa}$
- Comparative statics:

$$\frac{d \log(P_T)}{d\tau} = -\frac{d \log(\tilde{z}(\tau))}{d\tau} > 0$$
$$\frac{d \log(P_X)}{d\tau} = -\kappa \frac{d \log(\tilde{z}(\tau))}{d\tau} > 0$$

Quantitative Analysis

Quantitative Analysis

- Calibrate model to match features of U.S. economy
- Experiment
  - impose a tariff of 20 percent
  - compute transition to new steady state
- Various fiscal policies
  - increase government expenditure
  - reduce labor income tax
  - reduce capital income tax
  - lump-sum redistribute

Calibration

- Preferences:

Parameters	Values	Targets / Source
Discount factor β	0.96	Wealth-to-GDP: 4.8 (2014)
Risk aversion σ	2	Standard value
Tradable share γ	0.27	Tradable exp. share: 36% (2004–14)
Non-homotheticity $\bar{c}$,	0.09	Tradable exp. share of top wealth quartile: 31 percent (2004–14)
Disutility from labor ψ	440	Average hours: 30 percent
Frisch elasticity $1/\nu$	0.5	Standard value

- Tradable expenditure shares decline with wealth figures (Carroll and Hur 2019a)

Calibration

- Technology:

$$F(L,H,K) = \left[(1-\mu)\,L^{\zeta} + \mu[(1-\alpha)\,H^{\chi} + \alpha K^{\chi}]^{\frac{\zeta}{\chi}}\right]^{\frac{1}{\zeta}}$$

Parameters	Values	Targets / Source
Skilled fraction, $\bar{H}$	0.33	Skilled labor force: 33 percent
Capital weight, α	0.83	Capital income share: 36 percent
Skilled weight, μ	0.61	Skilled labor inc. share: 36 percent
Elasticity of substitutions,		
unskilled–capital, $1/(1-\zeta)$	1.67	Krusell et al. (2000)
skilled–capital, $1/(1-\chi)$	0.67	Krusell et al. (2000)

Calibration

- Assume $\tau_P = 0$ (less than 2% of gov't revenue in 2014)
- Other parameters:

Parameters	Values	Targets / Source
Elas. of subs. between		
tradable intermediates, θ	5.7	Trade elasticity: 4
Factor elasticity, κ	0.59	Tradable input shares in capital production
Productivity distribution, η	1.29	Employment share of top 17 percent of large manufacturing establishments: 32 percent
Iceberg cost, $(\tau - 1) \times 100$	0.27	Import share: 17 percent
Income tax, $\tau_\ell = \tau_k$	0.19	Government consumption: 15 percent of GDP

Productivity shocks

- ε follows a finite-state Markov process which approximates the continuous process,

$$\log \varepsilon_t = \rho_\varepsilon \log \varepsilon_{t-1} + \nu_t, \nu_t \sim N\left(0, \sigma_\nu^2\right)$$

- We set $\rho_\varepsilon = 0.92$ and $\sigma_\nu = 0.21$ following Floden and Linde (2001)

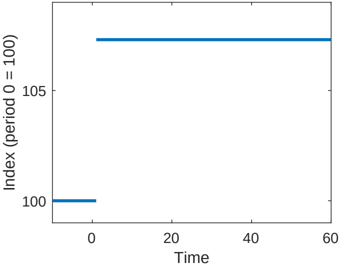
Main results

- Average welfare losses
  - lowest average welfare with wasteful government spending
  - labor income tax reduction delivers higher average welfare than capital income tax reduction, but also lower GDP
  - small average welfare increase from lump-sum redistribution
- Distribution of welfare
  - absent redistribution, tariffs harm skilled more than unskilled and poor more than rich
  - unskilled benefit from lump-sum redistribution at the expense of the skilled

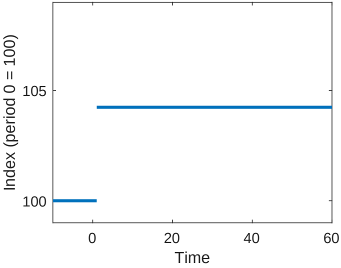
Effect of tariffs on prices

- Tradables price and investment price do not depend on how tariff revenue is spent.

(a) Tradables price

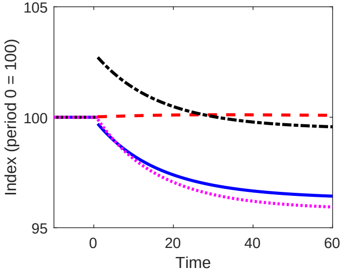


(b) Investment price

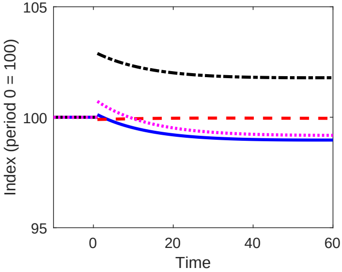


Effect of tariffs on factor prices

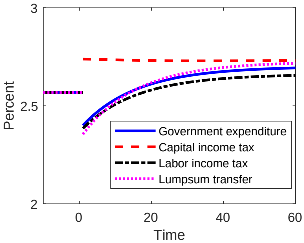
(a) After-tax skilled wage



(b) After-tax unskilled wage

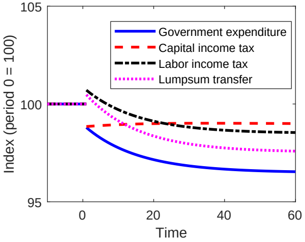


(c) After-tax net return

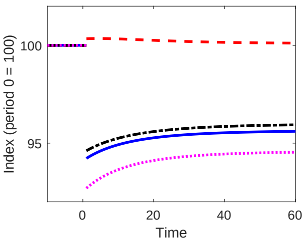


Effect of tariffs on economic activity

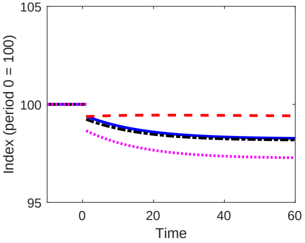
(a) Consumption



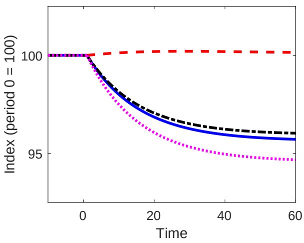
(b) Investment



(c) GDP



(d) Capital



Welfare Calculation

- For each household, we compute the consumption equivalence, Δ
- How much would initial steady state consumption have to be permanently increased for a household to be indifferent between raising tariffs or not?
- Solve for Δ such that $V_{j\Delta}(k,\varepsilon) = V_{j,t=1}(k,\varepsilon)$

$$V_{j\Delta}(k,\varepsilon) = u\left((1+\Delta)\, g^{ss}_{jT}(k,\varepsilon), (1+\Delta)\, g^{ss}_{jN}(k,\varepsilon), g^{ss}_{j\ell}(k,\varepsilon)\right) + \beta E_{\varepsilon'|\varepsilon} V_{j\Delta}\left(g^{ss}_{jk}(k,\varepsilon), \varepsilon'\right).$$

- If $\Delta > 0$, then the household supports tariffs. If $\Delta < 0$, then it does not.

Welfare

- lowest average welfare with wasteful government spending
- labor income tax reduction delivers higher average welfare than capital income tax reduction.
- small average welfare increase from lump-sum redistribution

Table: Average Welfare

Govt expenditure	-3.13
Capital inc. tax	-1.52
Labor inc. tax	-0.98
Lump-sum tax	0.23

Units: percent.

Welfare across skill type

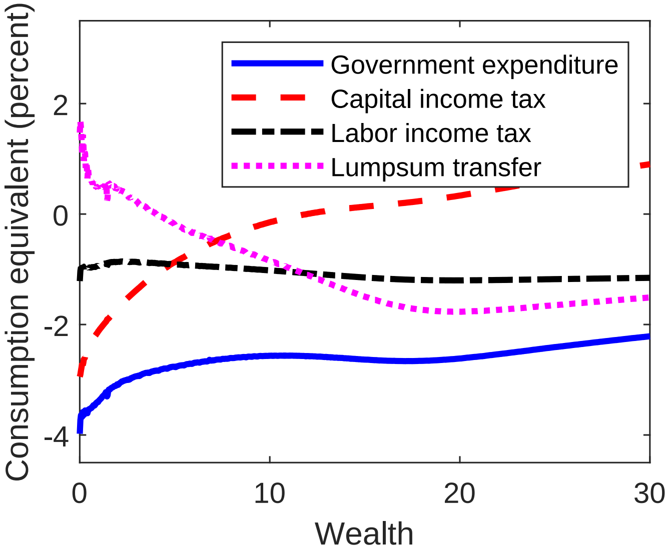
- absent redistribution, tariffs harm skilled more than unskilled and poor more than rich
- unskilled benefit from lump-sum redistribution at the expense of the skilled

Table: Average welfare by skill level

Fiscal policy	unskilled	skilled
Govt expenditure	−2.91	−3.57
Capital inc. tax	−1.80	−0.96
Labor inc. tax	−0.80	−1.35
Lump-sum tax	1.47	−2.30

Units: percent.

Welfare across the wealth distribution



Decomposing welfare changes

We conduct three partial equilibrium exercises to isolate effects on welfare from three channels

$$P_T c_T + c_N + P_X(k' - k) \leq \tilde{w}_j \ell \varepsilon + \tilde{r} k + T$$

- Expenditure channel: $P_T \uparrow$ makes tradable consumption more expensive.
- Poor vs. Wealthy

Decomposing welfare changes

We conduct three partial equilibrium exercises to isolate effects on welfare from three channels

$$P_T c_T + c_N + P_X(k' - k) \leq \tilde{w}_j \ell \varepsilon + \tilde{r} k + T$$

- Investment channel: $P_X \uparrow$ makes accumulating capital more expensive
- Savers vs. Dissavers

Decomposing welfare changes

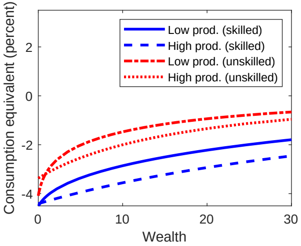
We conduct three partial equilibrium exercises to isolate effects on welfare from three channels

$$P_T c_T + c_N + P_X(k' - k) \leq \tilde{w}_j \ell \varepsilon + \tilde{r} k + T$$

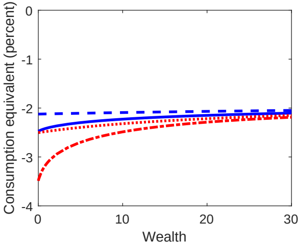
- Factor price channel: $\tilde{w}_j$ and $\tilde{r}$ change
- Labor vs Capital
- Skilled vs Unskilled

Welfare by channel (government spending)

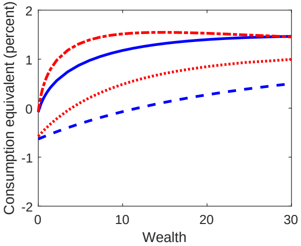
(a) Total



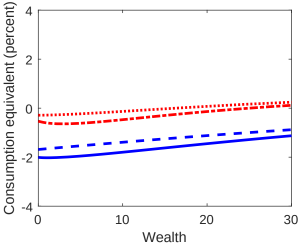
(b) Expenditure



(c) Investment



(d) Factor price



Decomposition of welfare changes for unskilled

	Low wealth		High wealth		
Channels	Low prod.	High prod.	Low prod.	High prod.	Average
Expenditure	−3.49	−2.50	−2.40	−2.27	−2.75
Investment	−0.08	−0.58	1.54	0.67	0.32
Factor price					
Govt Expend	−0.53	−0.29	−0.35	−0.04	−0.47
Capital inc. tax	0.09	0.90	2.13	2.45	0.71
Labor inc. tax	2.24	2.34	0.18	0.86	1.69
Lump-sum redist.	−0.15	0.14	−0.34	0.13	−0.18
All					
Govt Expend.	−4.09	−3.37	−1.25	−1.69	−2.91
Capital inc. tax	−3.49	−2.28	1.14	0.67	−1.80
Labor inc. tax	−1.40	−0.81	−0.70	−0.78	−0.80
Lump-sum redist.	3.98	−0.05	1.20	0.29	1.47

Units: percent.

Decomposition of welfare changes for skilled

Table: Decomposition of welfare changes for skilled

	Low wealth		High wealth		
Channels	Low prod.	High prod.	Low prod.	High prod.	Average
Expenditure	−2.48	−2.12	−2.16	−2.06	−2.20
Investment	−0.08	−0.63	1.35	0.34	0.37
Factor price					
Govt Expend	−2.01	−1.69	−1.51	−1.03	−1.74
Capital inc. tax	0.21	1.12	1.41	2.17	0.95
Labor inc. tax	1.04	1.19	−0.26	0.47	0.52
Lump-sum redist.	−2.20	−1.82	−1.76	−1.15	−1.95
All					
Govt Expend.	−4.52	−4.41	−2.35	−2.78	−3.57
Capital inc. tax	−2.36	−1.74	0.52	0.28	−0.96
Labor inc. tax	−1.55	−1.61	−1.09	−1.30	−1.35
Lump-sum redist.	−1.94	−3.45	−1.28	−2.08	−2.30

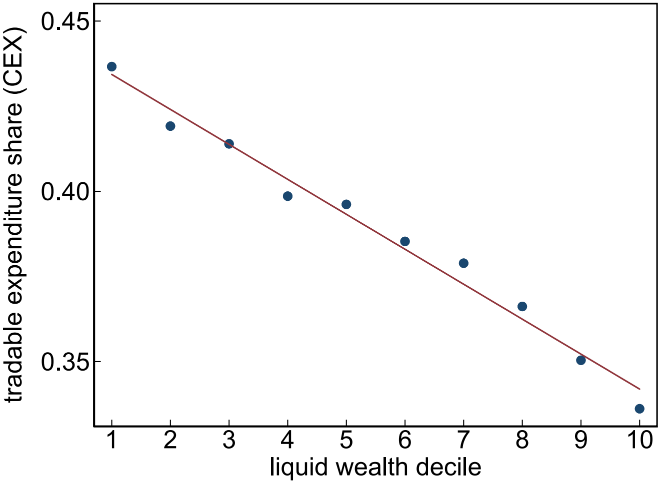
Units: percent.

Conclusion

- Without redistribution . . .
  - bilateral tariffs generate large welfare losses regardless of income/wealth/skill, but especially hurts the poor
  - raises the cost of their consumption
  - do not benefit from selling capital
  - their wage falls
- With redistribution . . .
  - capital income tax reduction leads to highest aggregate economic activity, but lowest average welfare (really hurts the poor)
  - Lump-sum rebating tariff revenue can produce a welfare gain on average, but at the expense of skilled

Appendix

Tradable expenditure shares decline with wealth back



Tradable expenditure shares decline with wealth back