On the Distributional Effects of International Trade and Tariffs

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Introduction

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- Effect on labor markets: Autor, Dorn, Hanson, and Song (2014)
  - low-skilled harmed more from opening to trade
- Effect on prices: Carroll and Hur (2019a,b)
  - poor most sensitive to tradable consumption prices (expenditure channel)
  - tradables are used to produce capital (investment channel)
  - capital accumulation (wage channel)

Overview

- Tradable goods/services constitute a larger fraction of expenditures for poor households (Carroll and Hur 2019a)
- Introduce a Ricardian trade model with
  - non-homothetic preferences
  - uninsurable income risk
  - skilled and unskilled labor
  - distortionary labor and capital income taxes
- Study the distributional effects of
  - the trade expansion of 2001{2014
  - the \trade war" of 2018{?

Empirical analysis

Data

- How do tradable expenditures vary with income/wealth?
- We use two complementary datasets:
  - Consumer Expenditure Survey (CEX, 2004{14)
    - \+ detailed expenditure categories
    - \+ self-reported owner-equivalent rent
    - { can't compute net worth: only liquid wealth
  - Panel Survey of Income Dynamics (PSID, 2004{14)
    - { more aggregated expenditure categories
    - { have to impute owner-equivalent rent
    - \+ detailed measures of wealth

Tradable expenditure shares (CEX)

- Total expenditures: 500+ expenditure categories
  - exclude mortgage interest, property taxes, home insurance
  - include self-reported owner's equivalent rent
- Tradable expenditures: 307 items
  - if imports or exports exceed 11 percent of production Examples
- 23,090 working-age household-year observations

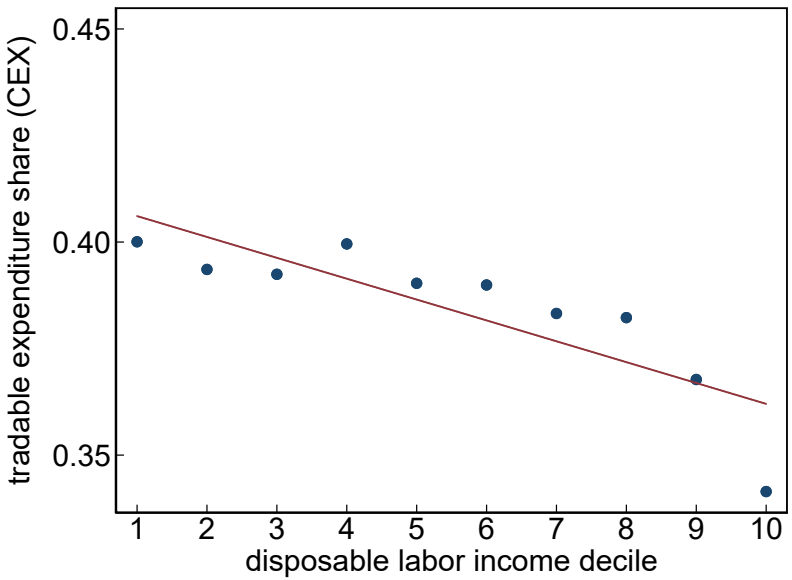
Tradable expenditure shares (PSID)

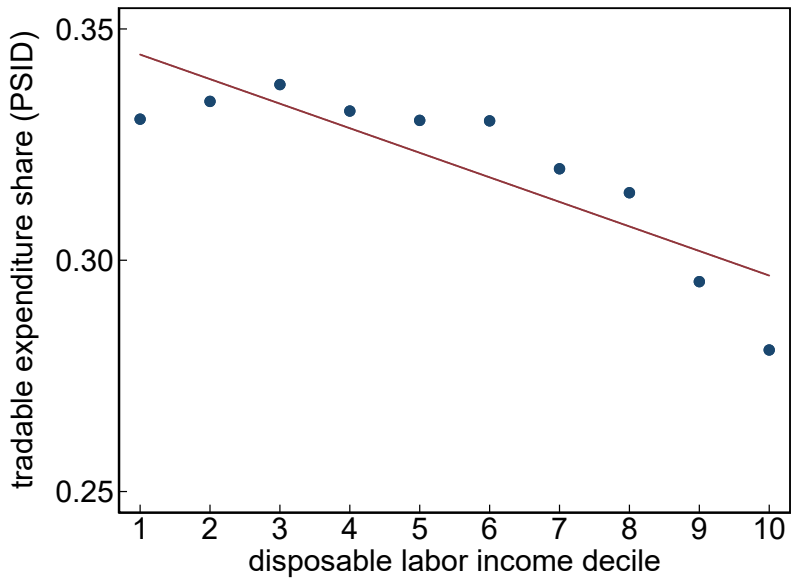
Exp. category	Tradable	Nontradable
Child care & education		X
Clothing	X	
Food	food at home	away from home
Health care	prescriptions	all other
Housing w/o repairs	furnishings	utilities, rent
Transportation w/o repairs	gasoline, purchase and lease of cars and trucks	all other
Vacation/ent.	21 percent	all other
Repairs	21 percent	all other

- : excludes mortgage, property taxes, and home insurance, but includes owner-equivalent rent, imputed by dividing state-level price-to-rent ratios from value of primary residence
- 30,228 working-age household-year observations

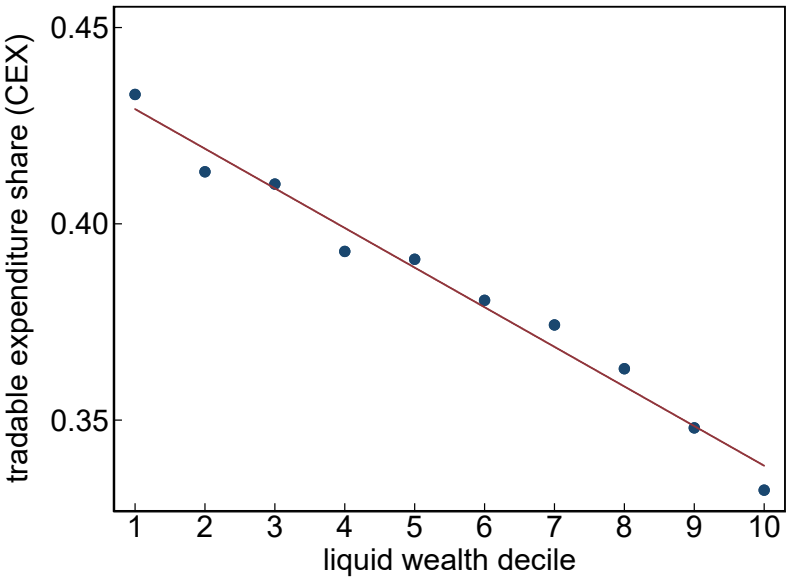
Tradable shares decline with labor income

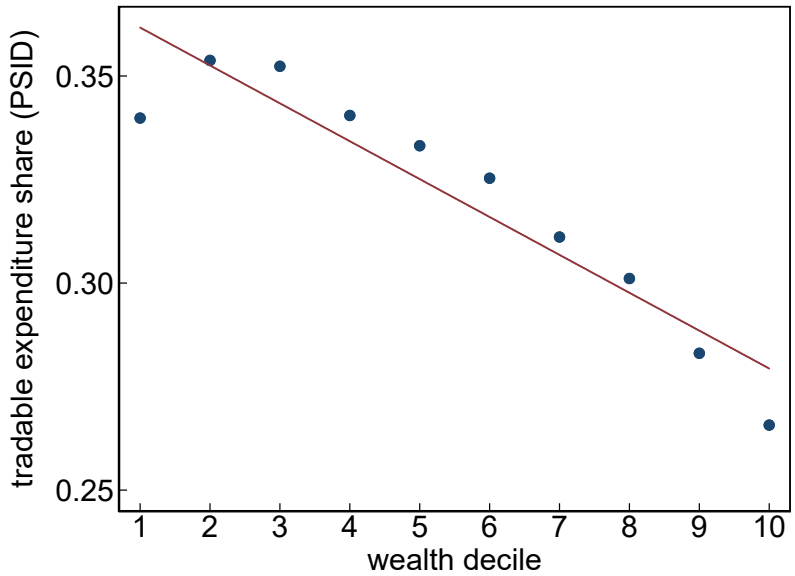
- Level is higher in CEX





Tradable shares decline with wealth





Related empirical work

- Boppart (2014) uses CEX to show that goods expenditure shares decline with income
- Borusyak and Jaravel (2018) also use CEX to show that *import* expenditure shares are *similar* across income groups
- We focus on *tradable* expenditure shares since trade can impact prices of all tradable goods and services through
  - increased competition
  - input-output linkages
- Many other papers use barcode data, which cover a small fraction of overall household expenditures

Summary of empirical findings

- Tradable expenditure shares decline with income and wealth
- Robust to controlling for household characteristics: Regressions
  - household head age and education
  - household size
  - home ownership
- Robust to: Sensitivity
  - not adjusting for owner-equivalent rent
  - no partial PSID adjustments (vacation/ent./repairs)
  - using total labor income
  - alternative tradability measures (to include indirect imports)

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  - alternative tradability measures (to include indirect imports)
- Motivates our model of
  - uninsurable income risk ! wealth and income heterogeneity
  - non-homothetic preferences ! di erent consumption baskets

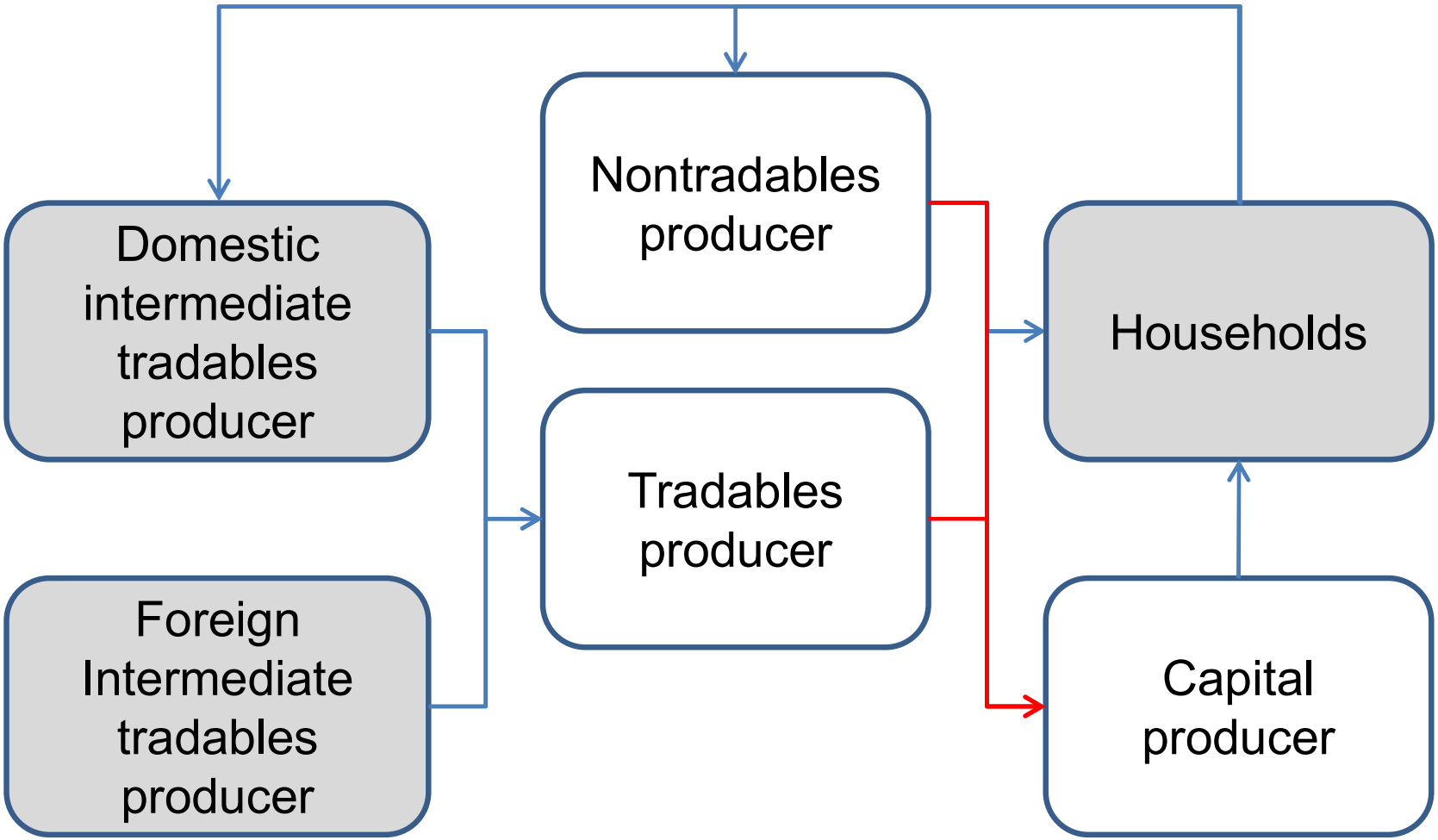
Model

Model

- Two 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/nontradables used for consumption/investment
  - ω *2* $[0, 1]$ continuum of tradable intermediate goods
- Government taxes to finance exogenous expenditures
- Capital-skill complementarity *)* trade increases skill premium

A brief overview the model

- We begin with the production of nontradables and capital



Non-tradables producer

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

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

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

Capital producer

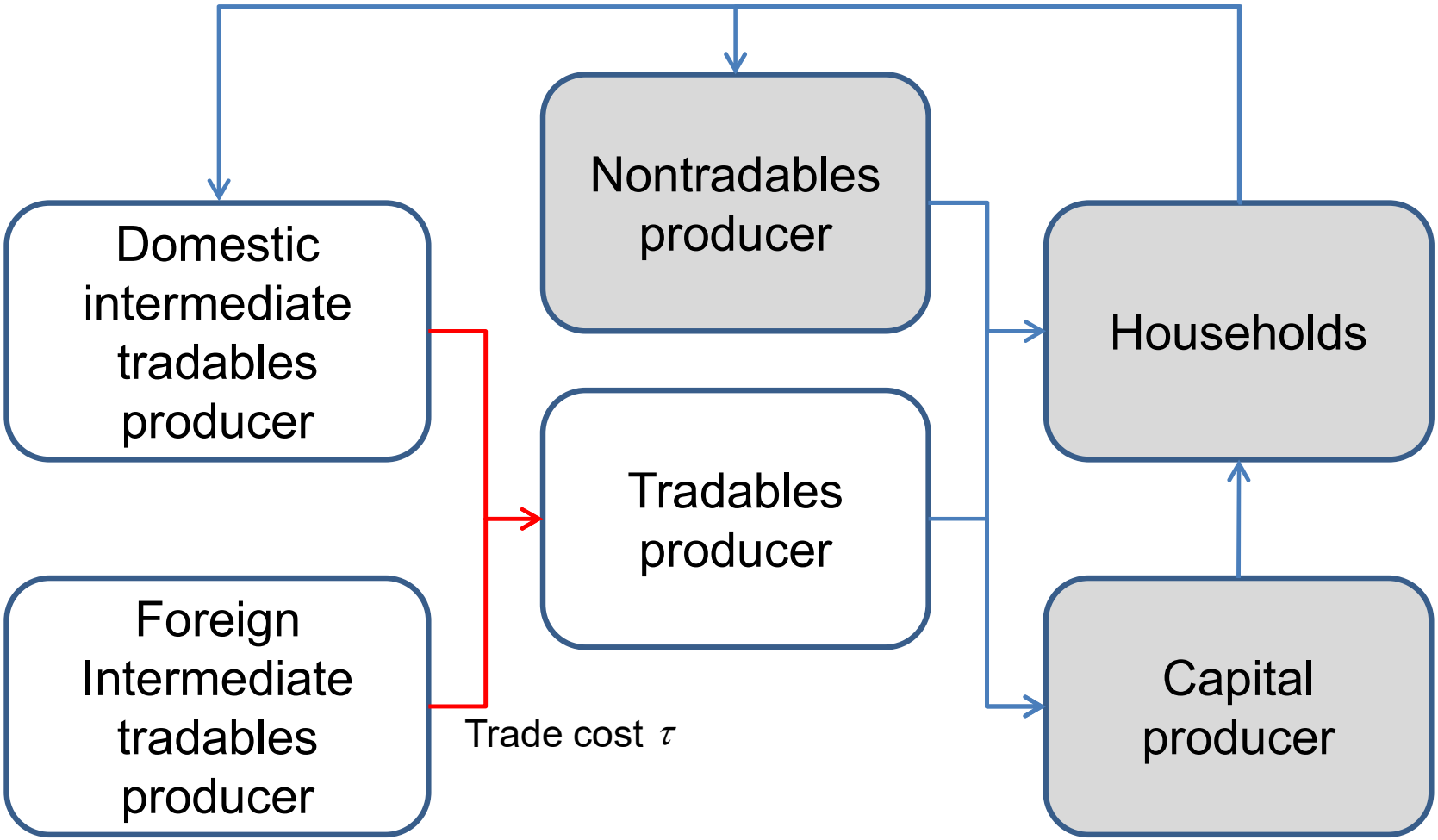
- A representative firm produces capital X_i, by solving

$$\max_{I_{iT};I_{iN}} P_{iX}X_i \quad P_{iT}I_{iT} \quad I_{iN}$$
$$\text{s.t. } X_i = z_{iX}I_{iT}I_{iN}^{1} \quad .$$

- The capital price is given by $P_{iX} = \frac{1}{z_{iX}} \left(\frac{P_{iT}}{\kappa}\right) \quad \left(\frac{1}{1 \quad \kappa}\right)^{1}$

Outline of model

- Let's discuss the production of tradable goods



Final tradables producer

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

$$\max_{f q_{oi}(\omega) g_{\omega}} P_{iT} Y_{iT} \quad \int_0^1 \sum_{o=1;2} \left[\tau_{oi} p_o(\omega) q_{oi}(\omega)\right] d\omega$$

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

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

- Solution: $q_{oi}(\omega) \quad \left(\frac{\tau_{oi} p_o(\omega)}{P_{iT}} \right) \quad Y_{iT}, \; = \;$ if $q_{oi}(\omega) > 0$.
- Price: $P_{iT} = \left[\int_0^1 \min_o f \tau_{oi} p_o(\omega) g^1 \quad d\omega \right]^{\frac{1}{1}}$ where $\theta = \frac{1}{1}$ 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

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

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

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

- Zero-profit price:

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

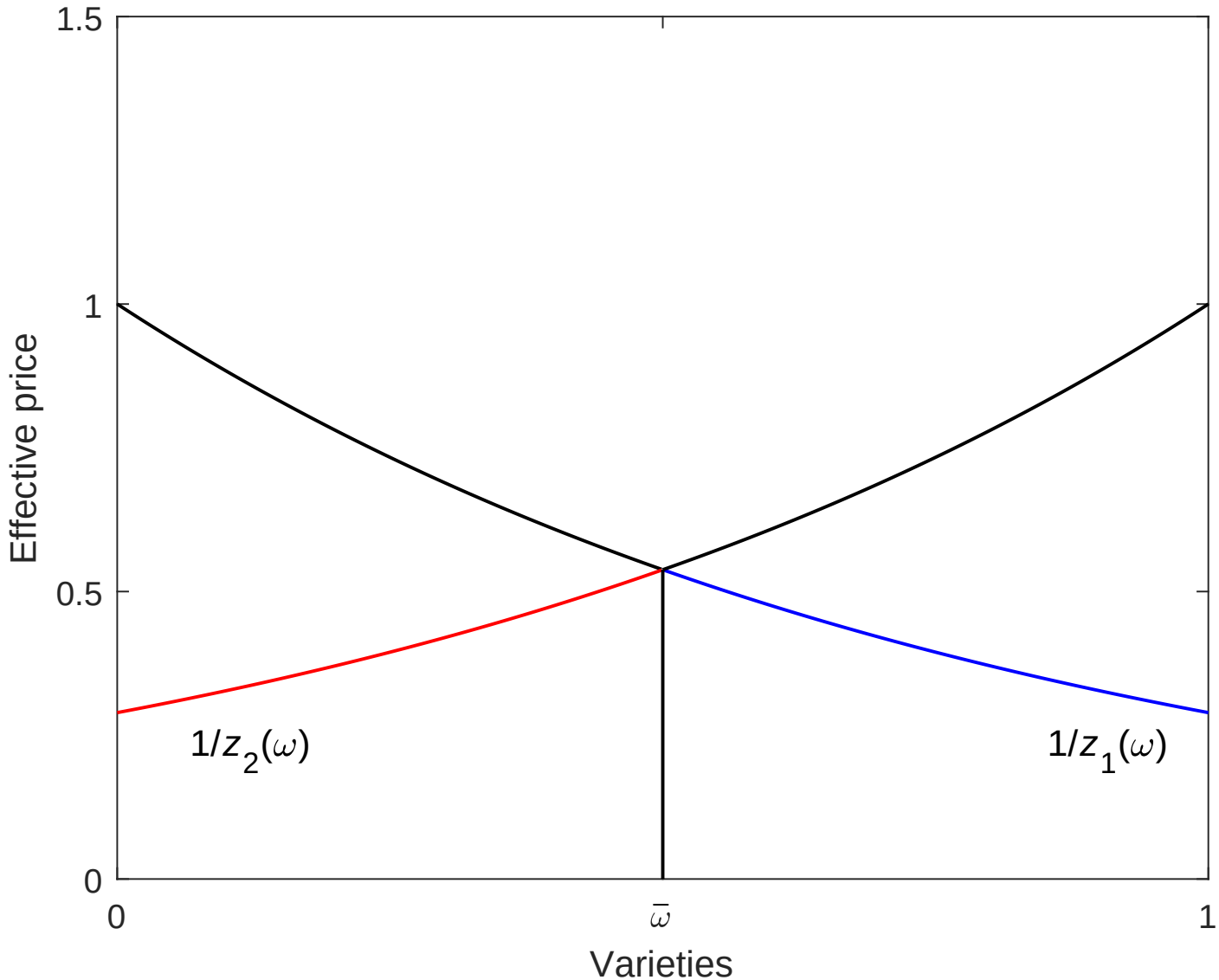
Productivity distributions in tradables production

- Productivities for variety ω are distributed according to

$$z_1(\omega) = e^{\quad !}$$
$$z_2(\omega) = e^{(1 \quad !)}$$

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

Pattern of production (free trade)



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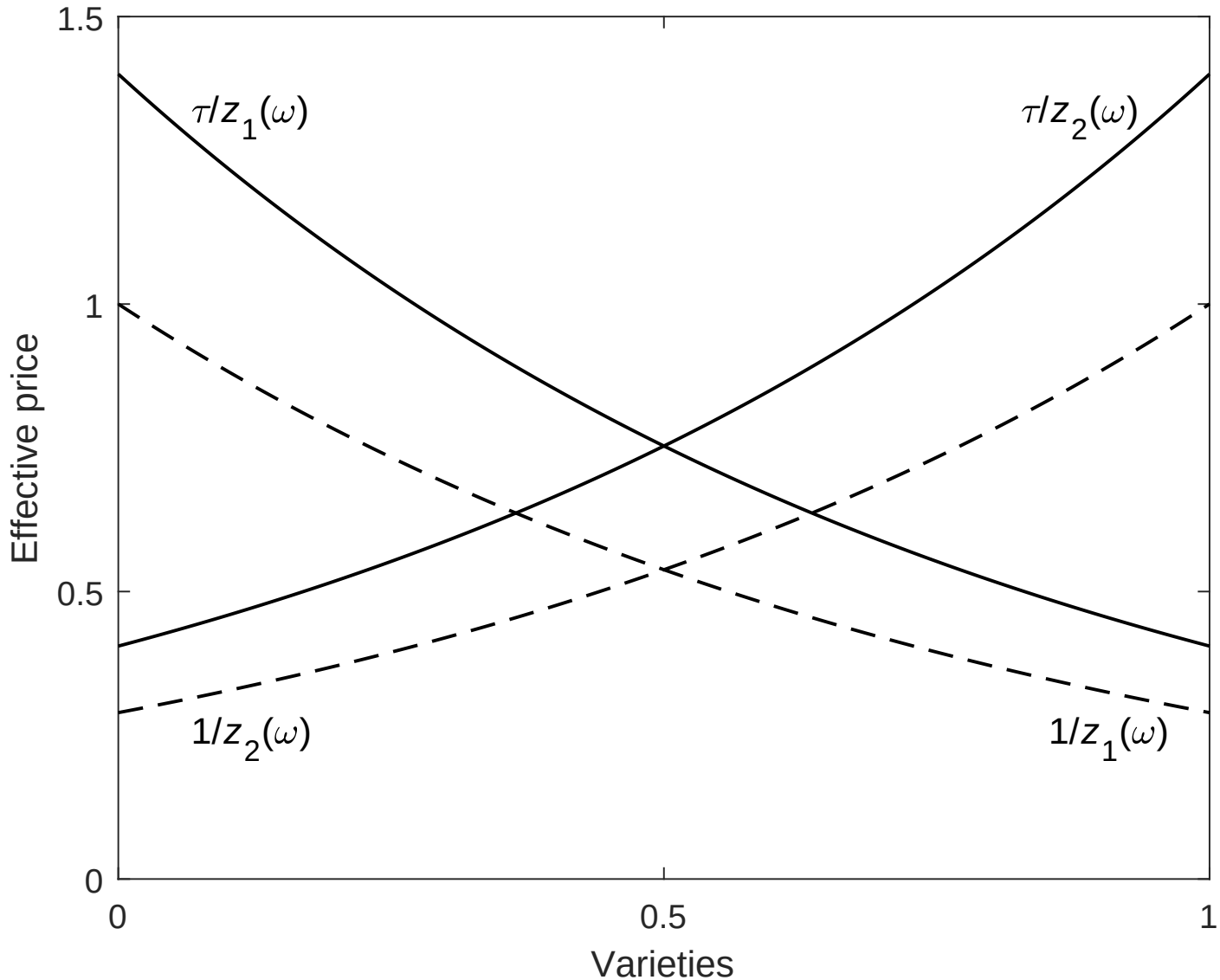

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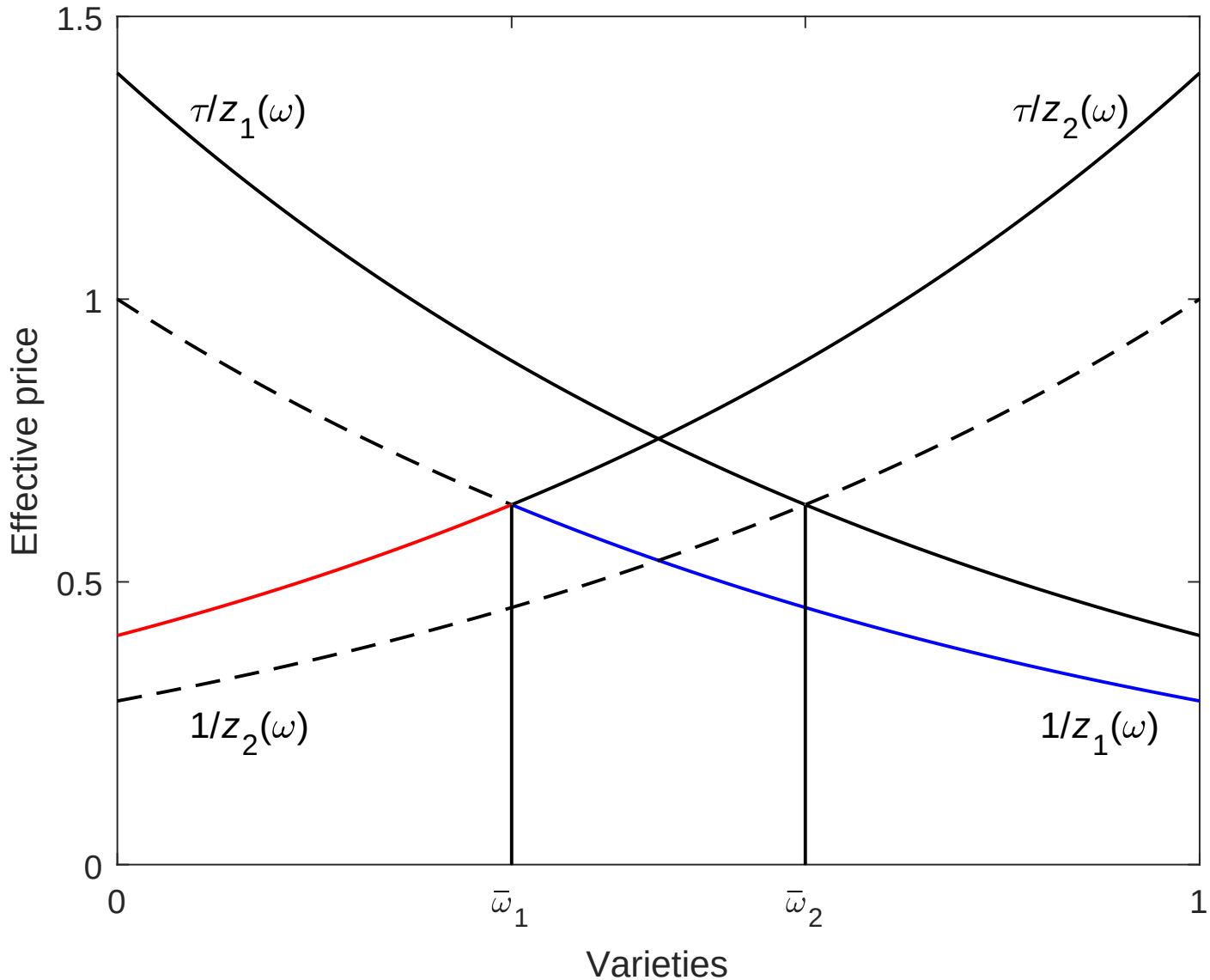

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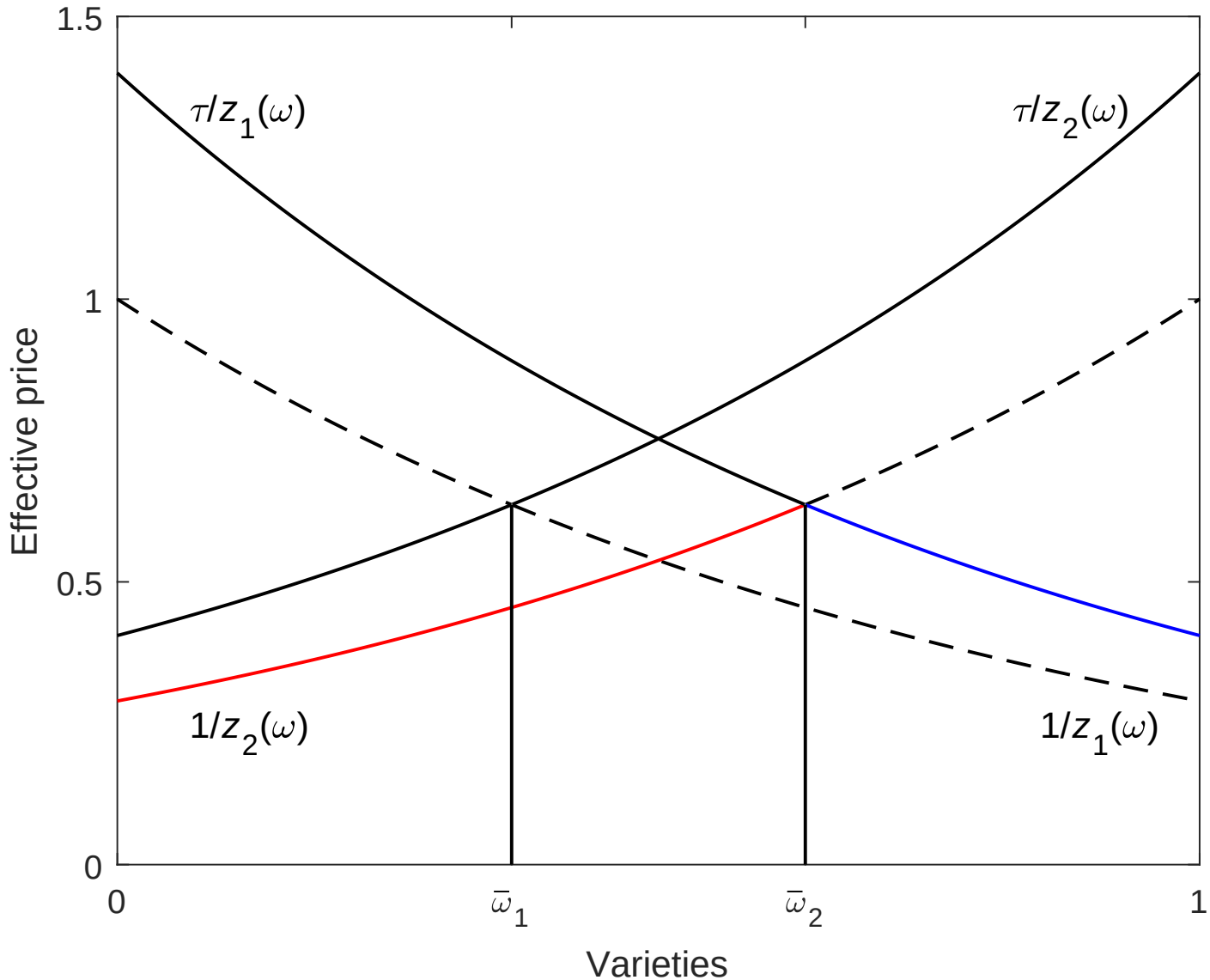

Outline of model

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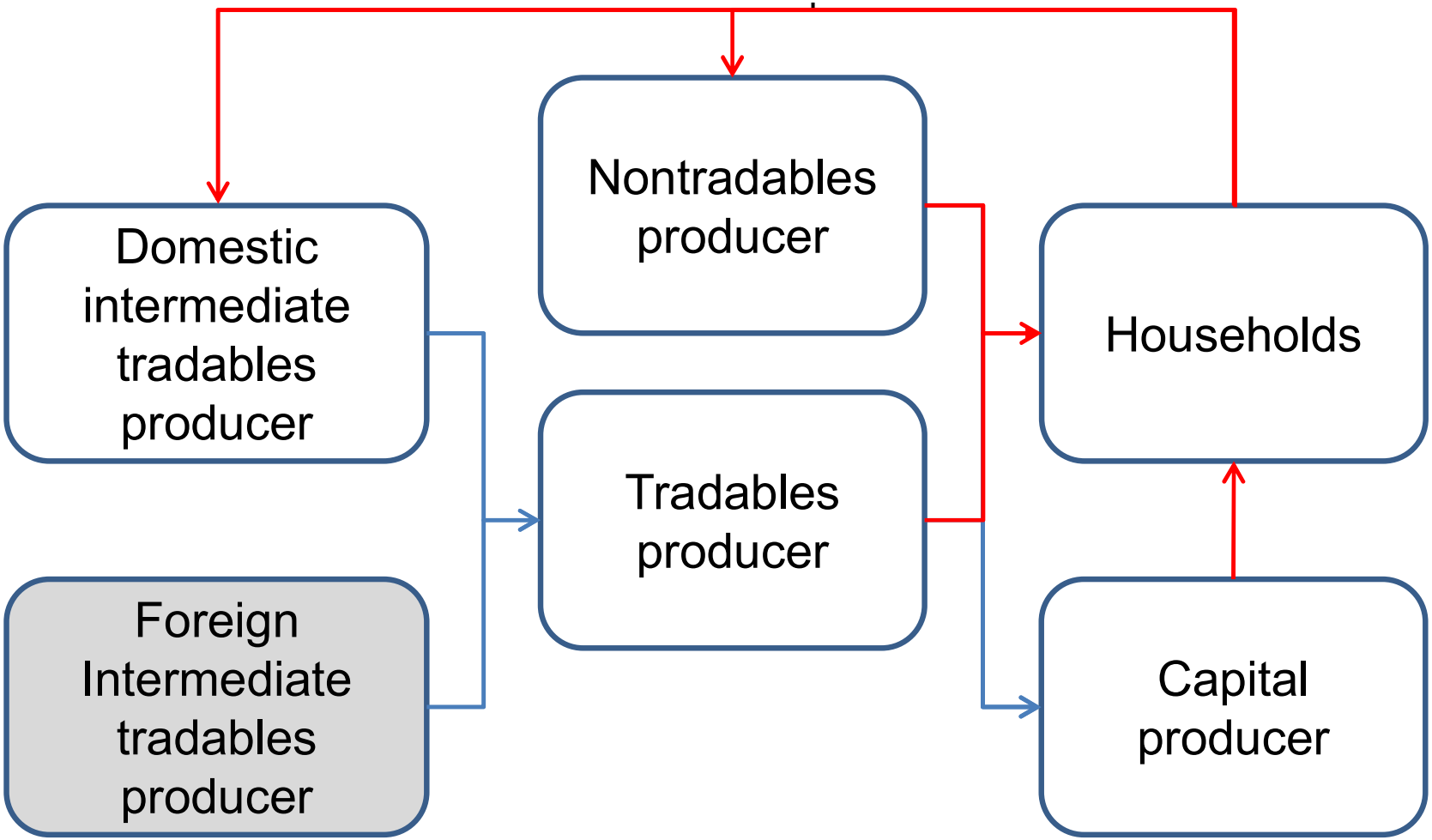

Households

- Household with skill type, j, solves

$$V_{ij}(k,\varepsilon) = \max_{c_T;c_N;`;k^0} u(c_T,c_N,\ell) + \beta E_{"^0j"} V_{ij}(k^0,\varepsilon^0)$$

$$\text{s.t.} \quad P_{iT}c_T + c_N + P_{iX}(k^0 \quad k) \quad \tilde{w}_{ij}\ell\varepsilon + \tilde{r}_i k + T_i,$$

$$k^0 \quad 0$$

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

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

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

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

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}
  - tari s, τ_{iP}
  - lumpsum tax/transfer, T_i

Equilibrium

A *steady-state recursive equilibrium*, given fiscal policies $\{\tau_{il}, \tau_{ik}, \tau_{iP}, G_i, T_i\}_{i=1,2}$, is for $i = 1, 2$,

- Functions $\{V_{ij}, g_{ijT}, g_{ijN}, g_{ij`}, g_{ijk}\}_{j=H,L}$,
- Nontradable producer plans $\{Y_{iN}, H_{iN}, L_{iN}, K_{iN}\}$,
- Final tradable producer plans $\left\{Y_{iT}, \{q_{oi}(\omega)\}_{\omega \in [0,1], o=1,2}\right\}$,
- Intermediate producer plans $\{y_i(\omega), h_i(\omega), l_i(\omega), k_i(\omega)\}_{\omega}$,
- Capital producer plans $\{X_i, I_{iT}, I_{iN}\}$,
- Prices $\{w_{iH}, w_{iL}, r_i, P_{iT}, P_{iX}, \{p_i(\omega)\}_{\omega}\}$, and
- Invariant distributions $\{\mu_{ij}\}_j$ 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: for $o \neq i$,

$$G_i + T_i = \tau_{il} \sum_j w_{ij} \int \varepsilon g_{ij'}(k, \varepsilon)\, d\mu_{ij}(k, \varepsilon)$$
$$+ \tau_{ik}(r_i - \delta P_{iX}) \sum_j \int k d\mu_{ij}(k, \varepsilon) + \tau_{iP} \int q_{oi}(\omega) d\omega.$$

7. For any (K, E) 2 B, the invariant distribution μ_{ij} satisfies

$$\mu_{ij}(K, E) = \int_S \sum_{\varepsilon' \in E} 1_{\{g_{ijk}(k;\varepsilon') \in K\}} \Gamma(\varepsilon', \varepsilon)\, d\mu_{ij}(k, \varepsilon).$$

Characterization of equilibrium

- The tradable price is given by $P_T = \frac{1}{\tilde{z}(\tau)}$,

  where $\tilde{z}(\tau)$ is a measure of aggregate productivity:

$$\tilde{z}(\tau) = \left[\int_0^{\tau(\ )} \left(\frac{z_2(\omega)}{\tau} \right)^{1} d\omega + \int_{\tau(\ )}^1 z_1(\omega)^{1} d\omega \right]^{\frac{1}{1}}$$

- Trade costs distort ...

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- Trade costs distort the extensive and intensive margins

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- The capital price is given by $P_X = \frac{1}{z_X} \left(\frac{P_T}{\kappa} \right) \left(\frac{1}{1 \quad \kappa} \right)^{1}$
- 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
  - US vs. ROW (China + OECD { US)
- Experiments
  1. reduce trade costs to simulate the trade expansion
  2. raise tari s
     - with and without retaliation
     - with and without redistribution

Calibration

- Preferences:

Parameters	Values	Targets / Source
Discount factor β	0.97	Wealth-to-GDP: 4.8 (2014)
Risk aversion σ	2	Standard value
Tradable share γ	0.26	Tradable exp. share: 35% (2004{14)
Non-homotheticity c,	0.11	Tradable exp. share of wealthiest quarter: 31 percent (2004{14)
Disutility from labor ψ	440	Average hours: 33 percent
Frisch elasticity $1/\nu$	0.5	Standard value

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	5.72	Trade elasticity: 4
Factor elasticity, κ	0.56	Tradable input shares in capital
Productivity distribution, η	1.29	Emp. share of top 17 percent of large mfg. est.: 32 percent
Iceberg cost, τ 1	0.10	Import share: 17 percent
Income tax, $\tau_\ell = \tau_k$	0.20	Gov't consumption: 15% of GDP
Depreciation, δ	0.05	Standard value

Calibration

- Production function with capital-skill complementarity

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

Parameters	Values	Targets / Source
Skilled fraction, H	0.33	Skilled labor force: 33 percent
Capital weight, α	0.85	Capital income share: 36%
Skilled weight, μ	0.51	Skilled wage premium: 81%
Elasticity of substitutions,		
unskilled-capital, $1/(1 \quad \zeta)$	1.67	Krusell et al. (2000)
skilled-capital, $1/(1 \quad \chi)$	0.67	Krusell et al. (2000)

Productivity shocks

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

$$\log \varepsilon_t = \rho'' \log \varepsilon_{t\ \ 1} + \nu_t, \nu_t \qquad N\left(0, \sigma^2\right)$$

- Estimate using PSID
  - ρ'' = 0.935 and σ = 0.195 (skilled)
  - ρ'' = 0.938 and σ = 0.182 (unskilled)

Experiment 1: Reduce trade barriers

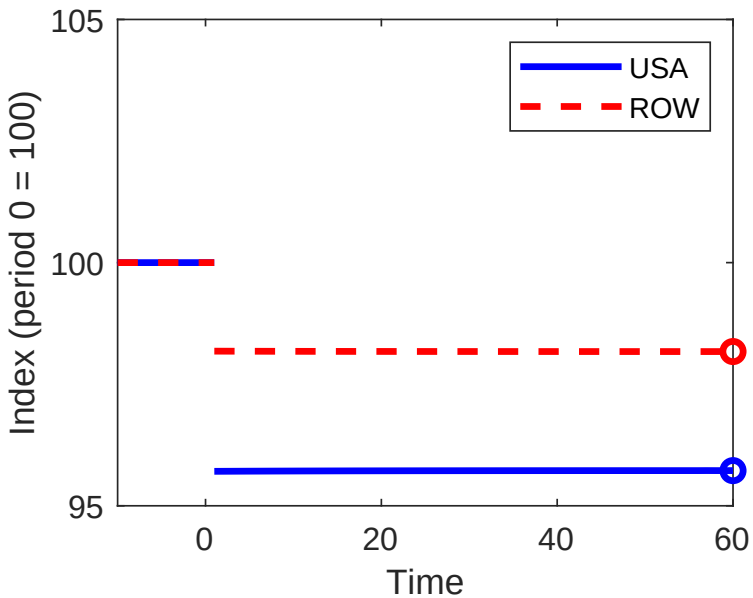
Main results

- Lower trade costs lead to
  - decline in tradables and investment price
  - capital deepening
  - increase in wage and skill premium
  - higher net return to capital during the transition
  - sizable average welfare gain, especially for wealth-poor

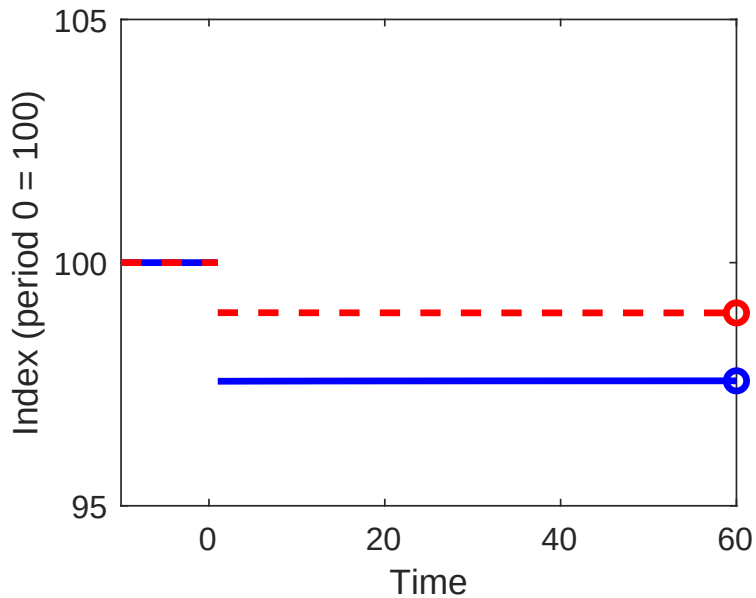
Prices

- Tradables and investment prices decline

(a) Tradables price



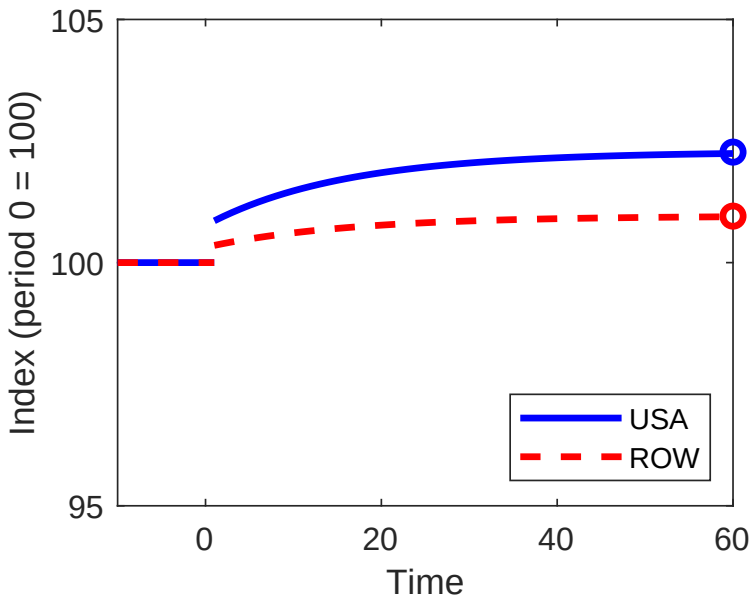
(b) Investment price



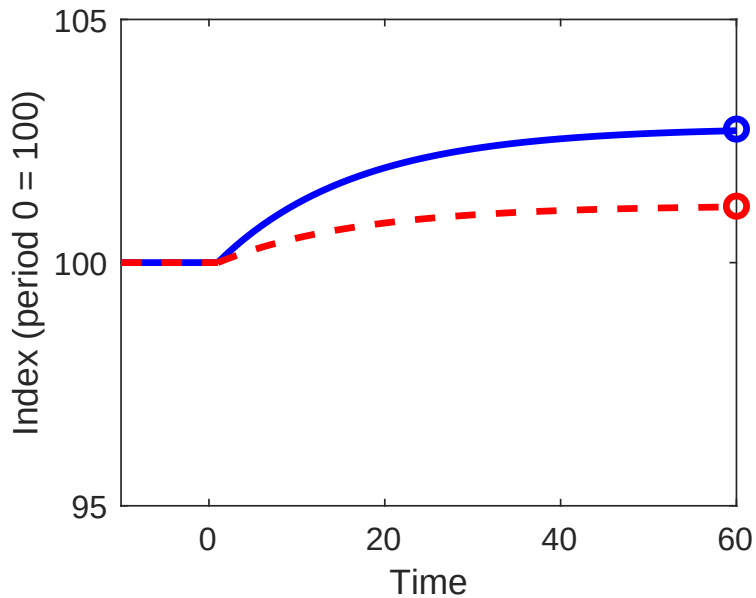
Quantities

- Consumption and investment increase

(a) Consumption



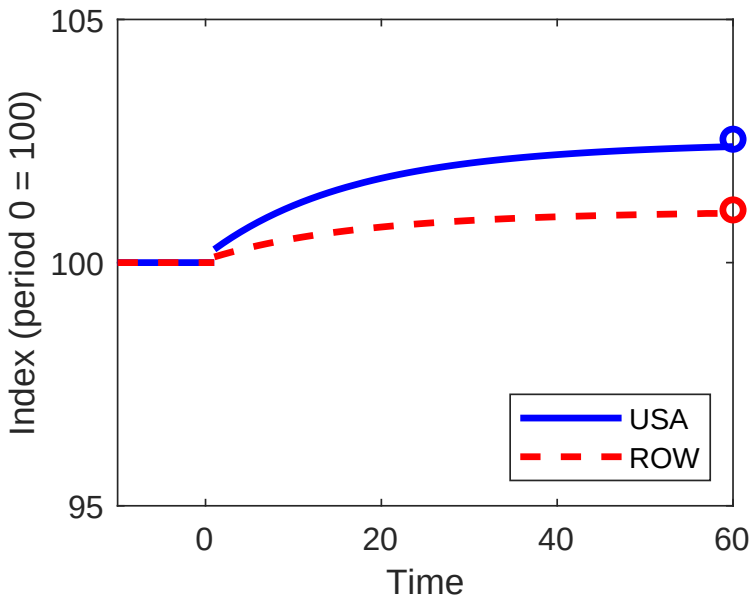
(b) Investment



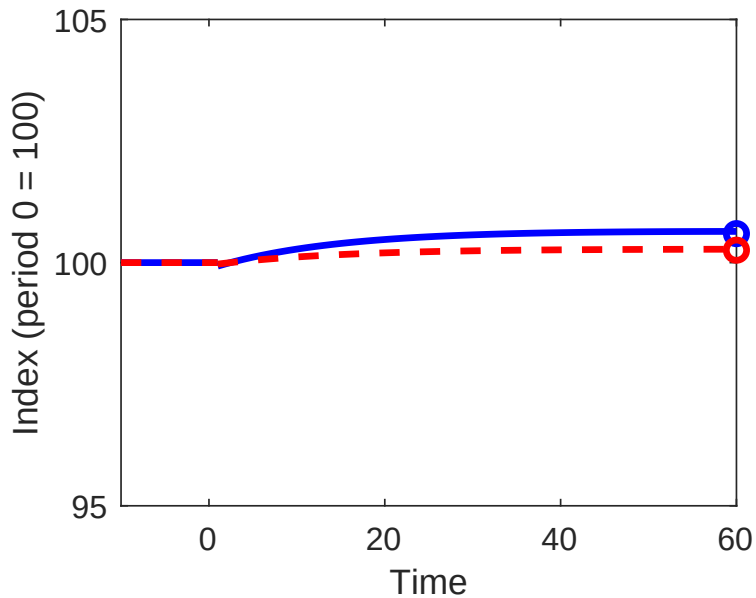
Wages

- Skilled wages increase by more than unskilled wages

(a) Skilled wage



(b) Unskilled wage



Welfare Calculation

- For each household, we compute consumption equivalence, Δ
- How much would initial steady state consumption have to be permanently increased for a household to be indifferent to the decline in trade costs?
- Solve for Δ such that $V_{ij\Delta}(k,\varepsilon) = V_{ij;t=1}(k,\varepsilon)$

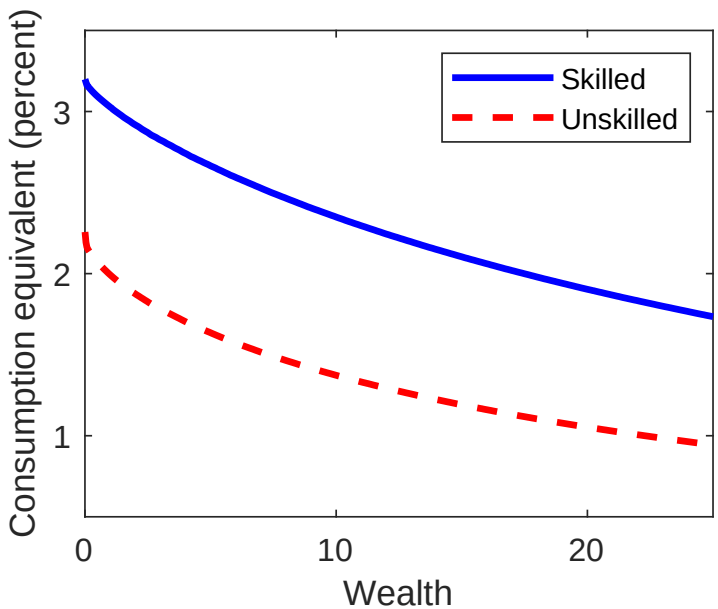
$$\begin{aligned} V_{ij\Delta}(k,\varepsilon) =& u\left((1+\Delta)\, g^{SS}_{ijT}(k,\varepsilon), (1+\Delta)\, g^{SS}_{ijN}(k,\varepsilon), g^{SS}_{ij`}(k,\varepsilon)\right) \\ &+ \beta E_{"0j"} V_{ij\Delta}\left(g^{SS}_{ijk}(k,\varepsilon), \varepsilon^{0}\right) \end{aligned}$$

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

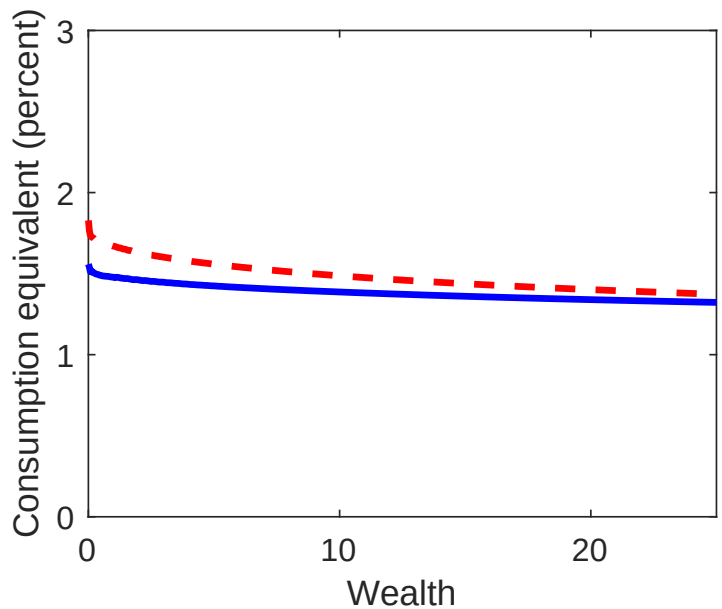
Welfare gains

- Welfare gains positive for all, but higher for poor and skilled

(a) Total



(b) Expenditure channel



Other channels

Experiment 2: Trade war

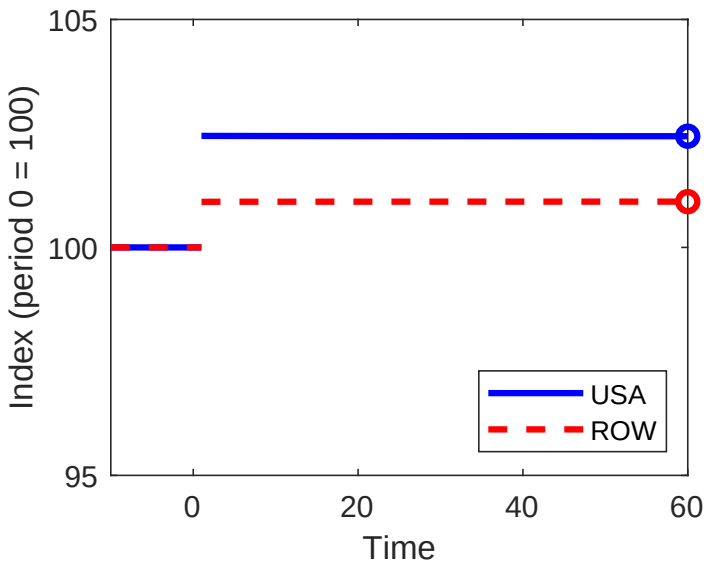
Main results

- Increase US tariffs by 5 percent
  - full retaliation by ROW
  - no retaliation
- First, we show the case with no redistribution and full retaliation
  - Partially reverses the gains from trade
  - higher tradable/investment prices
  - larger fall in skilled wage

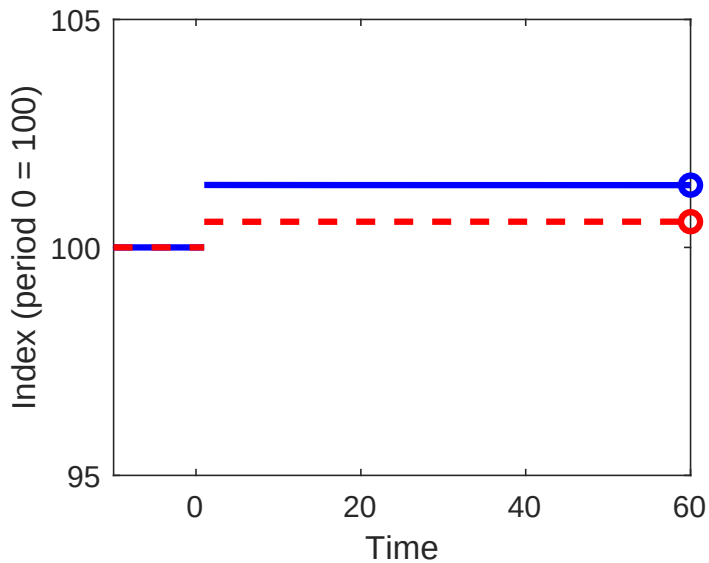
Effect of tariffs on prices

- Tradables price and investment price increase

(a) Tradables price



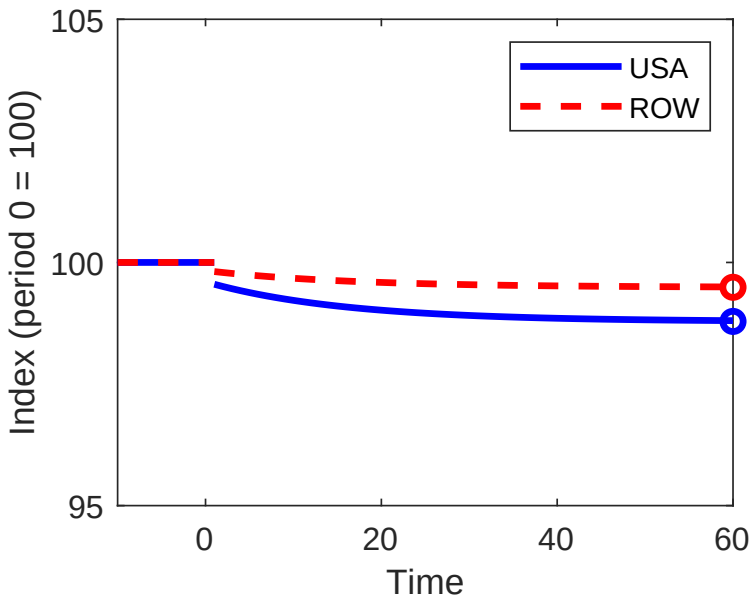
(b) Investment price



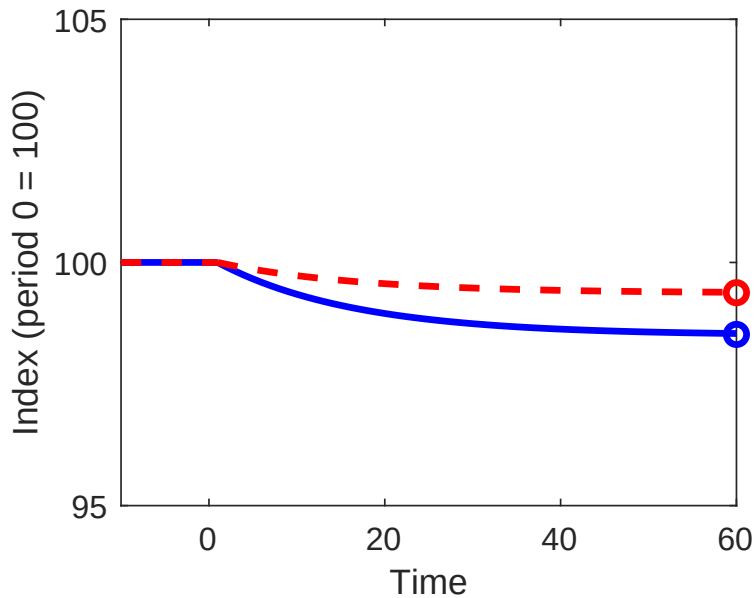
Effect of tariffs on aggregates

- Consumption and investment decline

(a) Consumption



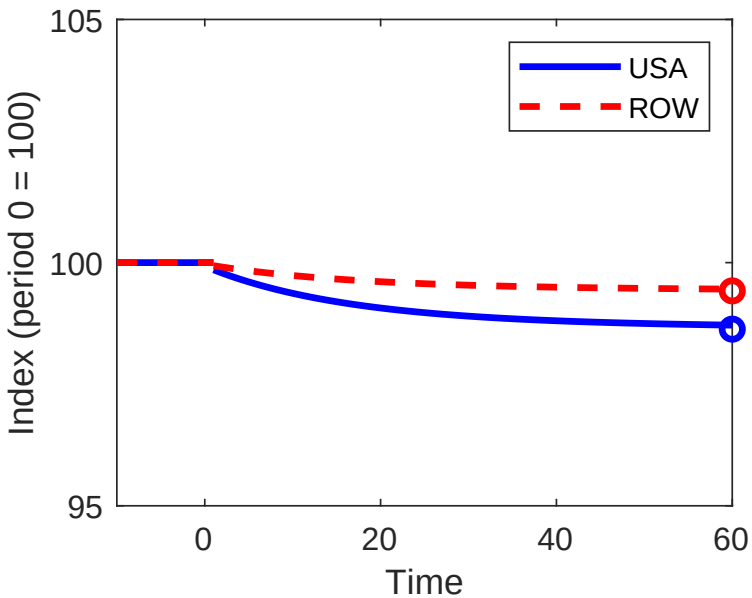
(b) Investment



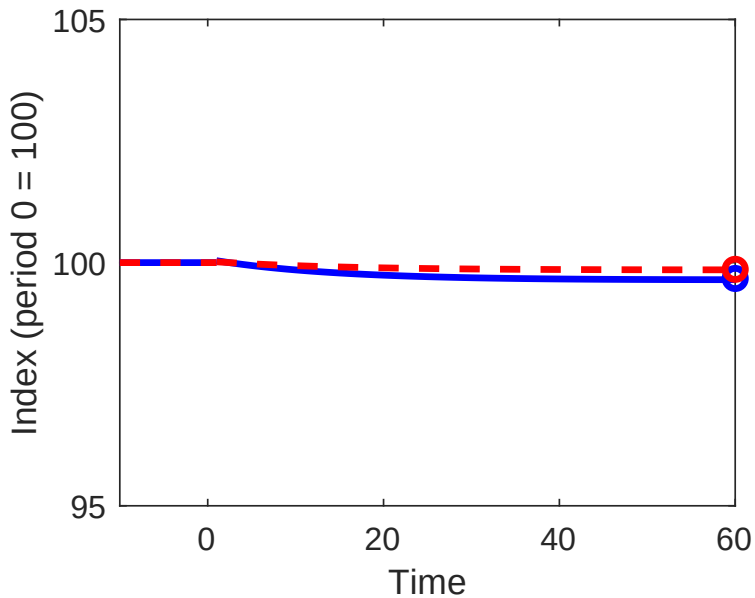
Effect of tariffs on wages

- Skilled wages fall by more

(a) Skilled wages



(b) Unskilled wages



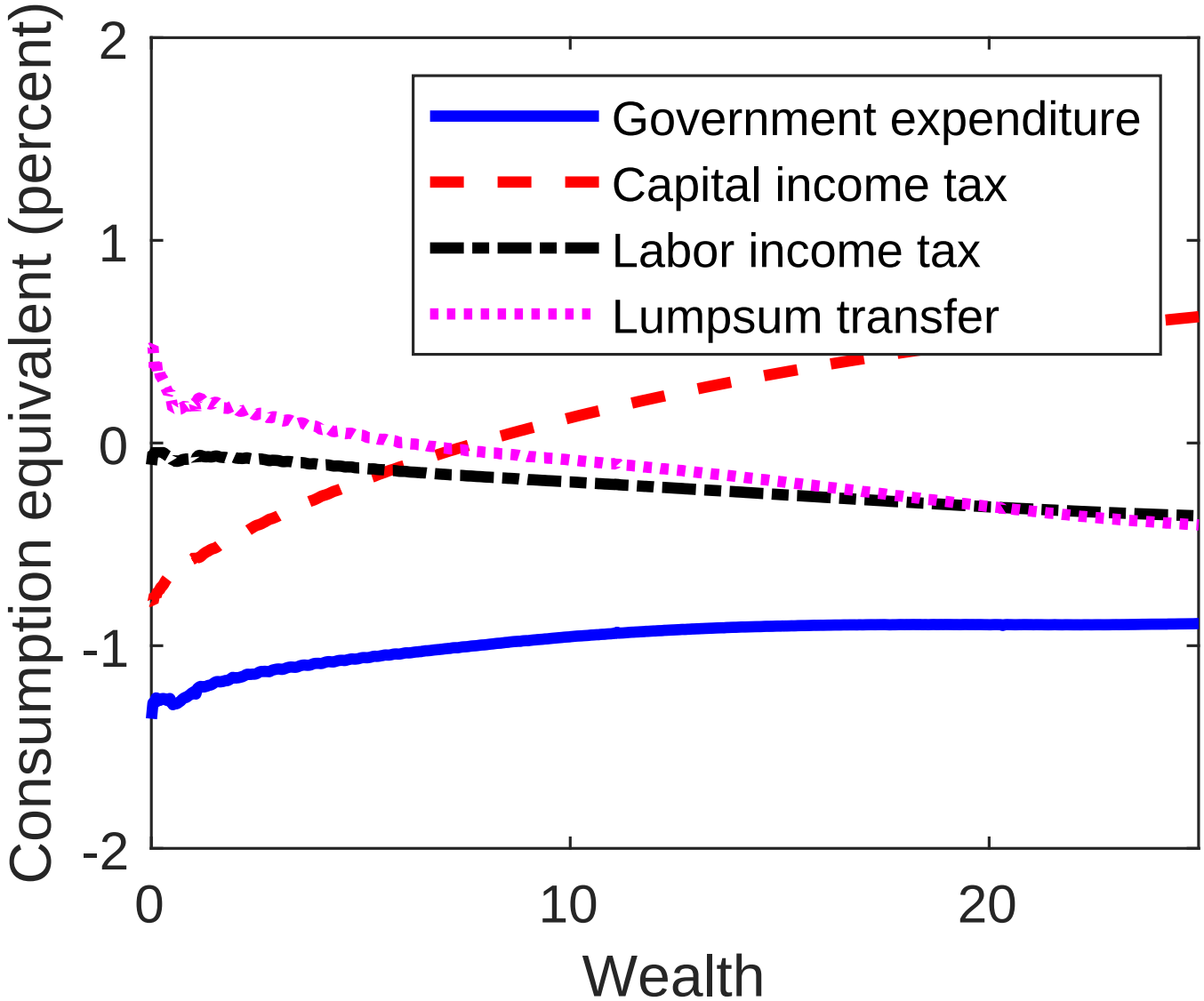
Welfare

- Welfare depends on how tariff revenue is redistributed
- Without redistribution
  - tari s harm everyone
  - but skilled more than unskilled and poor more than rich

Welfare

- Welfare depends on how tariff revenue is redistributed
- Without redistribution
  - tari s harm everyone
  - but skilled more than unskilled and poor more than rich
- With redistribution
  - 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, at the expense of the skilled

Welfare effects of tariffs Details



Tariffs with and without retaliation

- Welfare depends on how tariff revenue is redistributed and on extent of retaliation

Table: Welfare changes (average consumption equivalents)

Redistribution	Full retaliation	No retaliation
None	1.1	0.5
Capital income tax	0.3	0.4
Labor income tax	0.1	0.6
Lumpsum transfer	0.1	0.9

Units: percent

Key takeaways

- Poor and skilled households gain the most from trade
- They also lose the most from tariffs
- Welfare of trade war
  - crucially depends on how tari revenue is redistributed
  - reducing income taxes or increasing lumpsum transfers can generate some winners
  - but tari s (with full retaliation) reduce average welfare (excluding lumpsum redistribution)

Key takeaways

- Poor and skilled households gain the most from trade
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  - crucially depends on how tari revenue is redistributed
  - reducing income taxes or increasing lumpsum transfers can generate some winners
  - but tari s (with full retaliation) reduce average welfare (excluding lumpsum redistribution)
- Sectoral mobility matters
  - no mobility) wages respond more than prices

Next steps

- Limited mobility across sectors No mobility
- Multi-country, multi-industry model with asymmetric tariffs
- Quantify the distributional consequences of trade war
- Characterize the optimal sequence of tariffs/taxes in trade expansion

Appendix

Tradability measures back

CEX item	IO item	$\frac{\max(exp; imp)}{production}$	$\frac{exp + imp}{production}$	Tradable
Men's suits	Apparel manufacturing	6.47	7.06	yes
Calculators	Office supplies (except paper) mfg.	1.04	1.90	yes
Medical equipment	Surgical and medical instrument mfg.	0.31	0.78	yes
Beer/wine	Beverage mfg.	0.18	0.26	yes
Books, supplies eqmt for college	Book publishers	0.10	0.23	no/yes
Cigarettes	Tobacco product mfg.	0.04	0.10	no
Legal fees	Legal services	0.04	0.05	no
Dining out	Restaurants	0.00	0.00	no
Dental services	Offices of dentists	0.00	0.00	no
Median		0.18	0.41	

I : direct and indirect imports

Tradable shares, wealth, and income back

	Tradable expenditure share (percent)			
	(1) PSID	(2) PSID	(3) CEX	(4) CEX
ln(Wealth)	–1.03	–0.64	–1.10	–0.35
	(0.04)	(0.05)	(0.04)	(0.04)
ln(Income)	–0.21	–0.46	–0.15	–1.22
	(0.09)	(0.10)	(0.13)	(0.14)
College		–2.78		–3.35
		(0.15)		(0.19)
Homeowner		–1.30		–5.88
		(0.19)		(0.21)
Other controls	no	yes	no	yes
N	30244	30228	23090	23090
Adj. R^2	0.036	0.066	0.076	0.167

Standard errors in parentheses. All regressions include year fixed effects. Other controls include fixed effects for age and household size.

$p < 0{:}10$, $p < 0{:}05$, $p < 0{:}01$

Sensitivity analysis back

	Tradable expenditure share (percent, PSID)				
	(1) baseline	(2) no imputed	(3) no partial adjustment	(4) total lab. inc.	(5) county imput.
ln(Wealth)	0:64	0:33	0:76	0:76	0:45
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
ln(Income)	0:46	1:09	0:66	0:41	0:25
	(0.10)	(0.10)	(0.10)	(0.08)	(0.10)
N	30228	30228	30228	28212	30228
Adj. R^2	0.066	0.041	0.079	0.072	0.047

Standard errors in parentheses. $p < 0:10$, $p < 0:05$, $p < 0:01$
All regressions include year, age, household size, education, and homeowner fixed effects.

Sensitivity analysis back

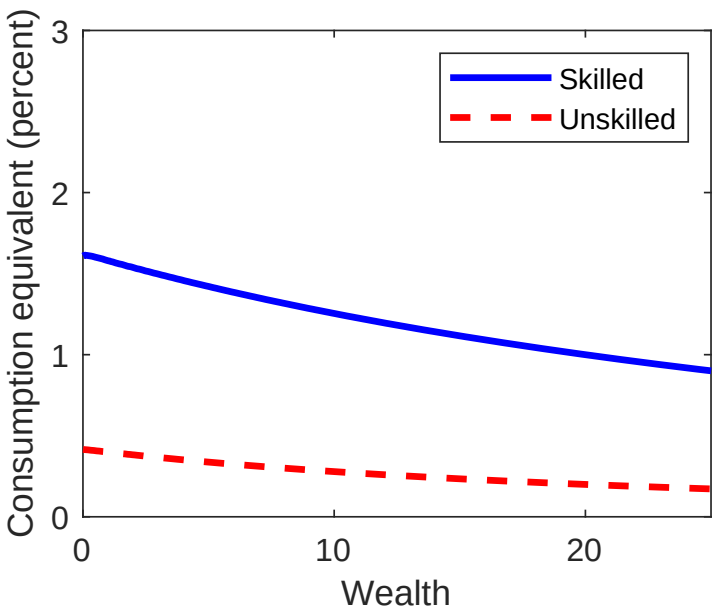
	Tradable expenditure share (percent, CEX)			
	(1) baseline	(2) no imputed rent	(3) total lab. inc.	(4) alternative tradability
ln(Wealth)	0:35	0:40	0:32	0:12
	(0.04)	(0.04)	(0.04)	(0.04)
ln(Income)	1:22	2:19	1:06	1:09
	(0.14)	(0.14)	(0.11)	(0.14)
N	23090	22993	21684	23090
Adj. R^2	0.167	0.108	0.165	0.136

Standard errors in parentheses. $p < 0:10$, $p < 0:05$, $p < 0:01$
All regressions include year, age, household size, education, and homeowner fixed effects.

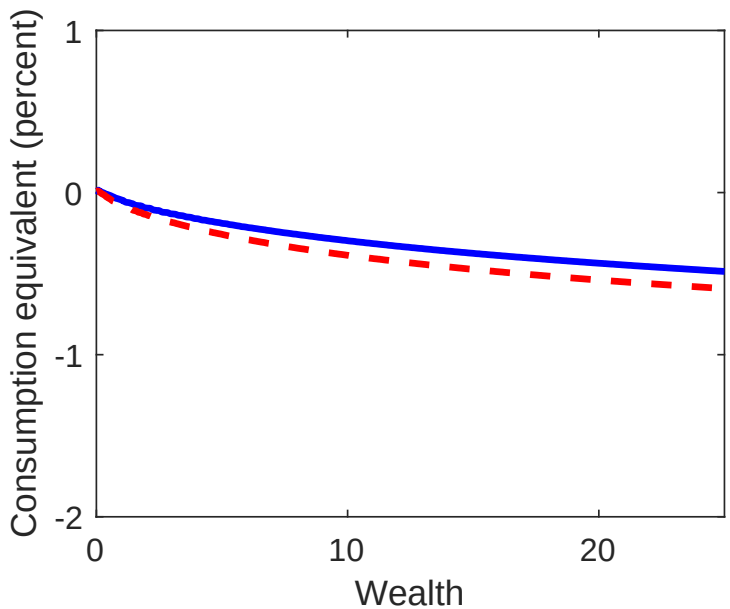
Other channels back

- Wage and investment channels also favor wealth-poor

(a) Wage channel



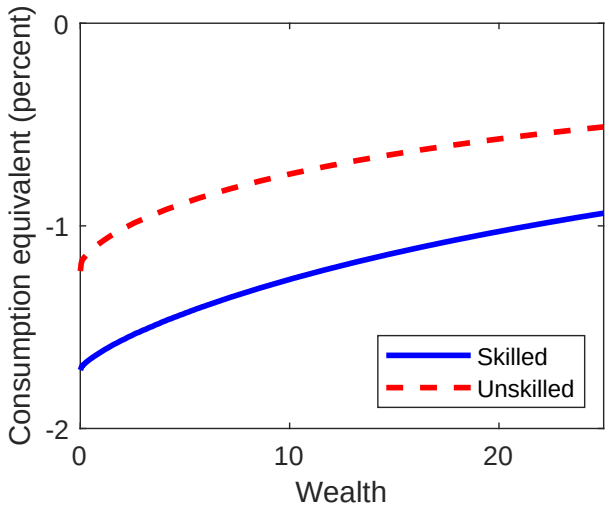
(b) Investment channel



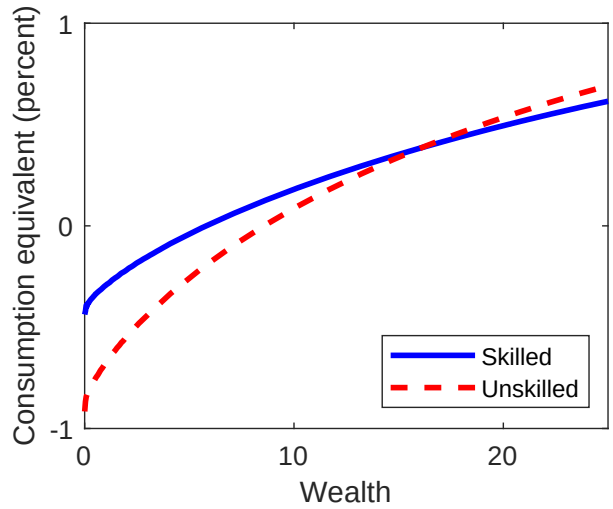
Welfare of tariffs with retaliation

back

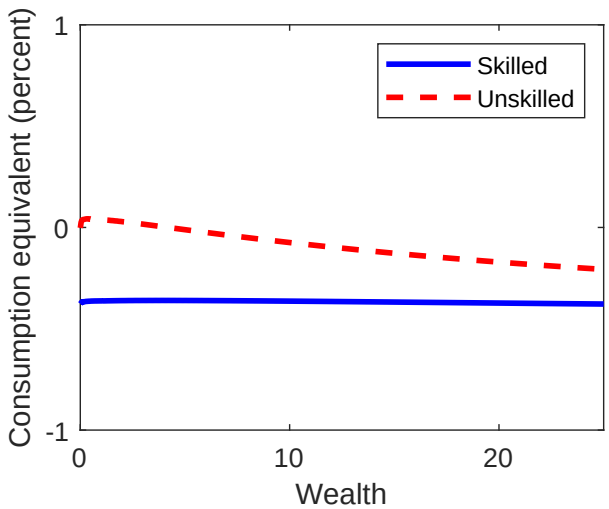
(a) Without redistribution



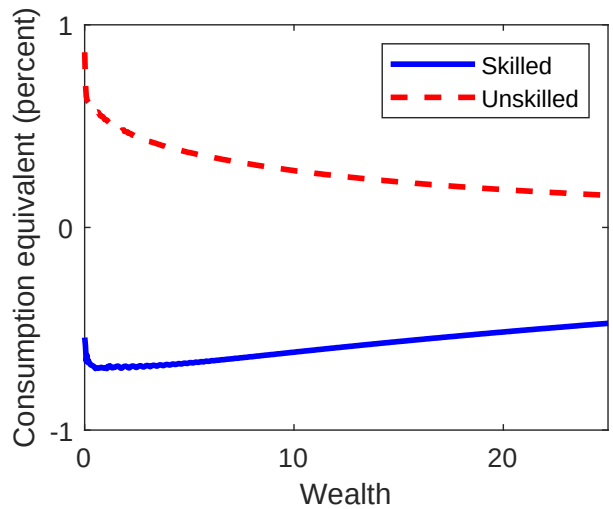
(b) Capital income tax



(c) Labor income tax



(d) Lumpsum transfer



No mobility across sectors

back

Figure: Welfare

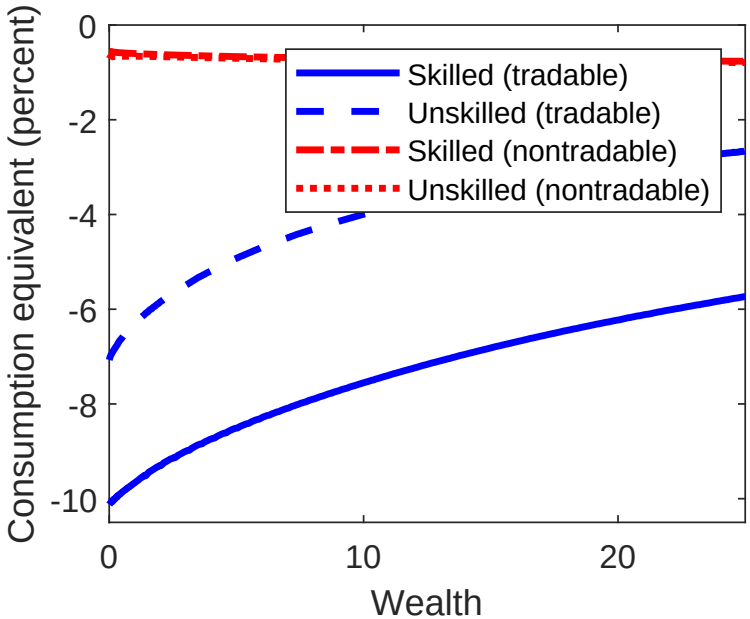


Figure: E ective wages