Trade Liberalization, an Employment Double-Dividend Hypothesis, and Welfare with Heterogeneous Firms

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Research Question

Can trade liberalization deliver
an Employment Double Dividend and a welfare gain?

Main findings: unemployment↑, emission↑, Welfare↓
(*if* country pay little attention to environment)

(An Employment Double-Dividend Hypothesis: Unemployment ↓ and environmental quality ↑.)

Out line of the Talk

1. Summary
2. **Introduction**
   - **Motivation and Literature Review**
3. The Model
   - Final-goods Firms
   - Intermediate-goods Firms
   - The Labor Market
   - Productivity Cutoffs
   - Aggregation
   - Government and a Hiring Subsidy
4. Trade Liberalization
5. An Employment Double-Dividend Hypothesis
6. Welfare
7. Conclusion

Unemployment and Environment: Literature

Employment Double-Dividend Hypothesis (Supported)

- Wagner (2005)

  Closed economy, tax reform,search model(Pissarides(2000)).
- Hadjidema and Eleftheriou (2013)

  Closed economy, tax reform, search model(Pissarides(2000)).
- Holmlund and Kolm (2000)

  Small open economy,tax reform, search model(Pissarides(2000)), welfare.
- Yamazaki (2017)

  Empirical, industry level data.

Unemployment and Environment: Literature

Employment Double-Dividend Hypothesis (Rejected)

- Bovenberg and de Mooij (1994), Fullerton (1997)

  Closed economy, tax reform.

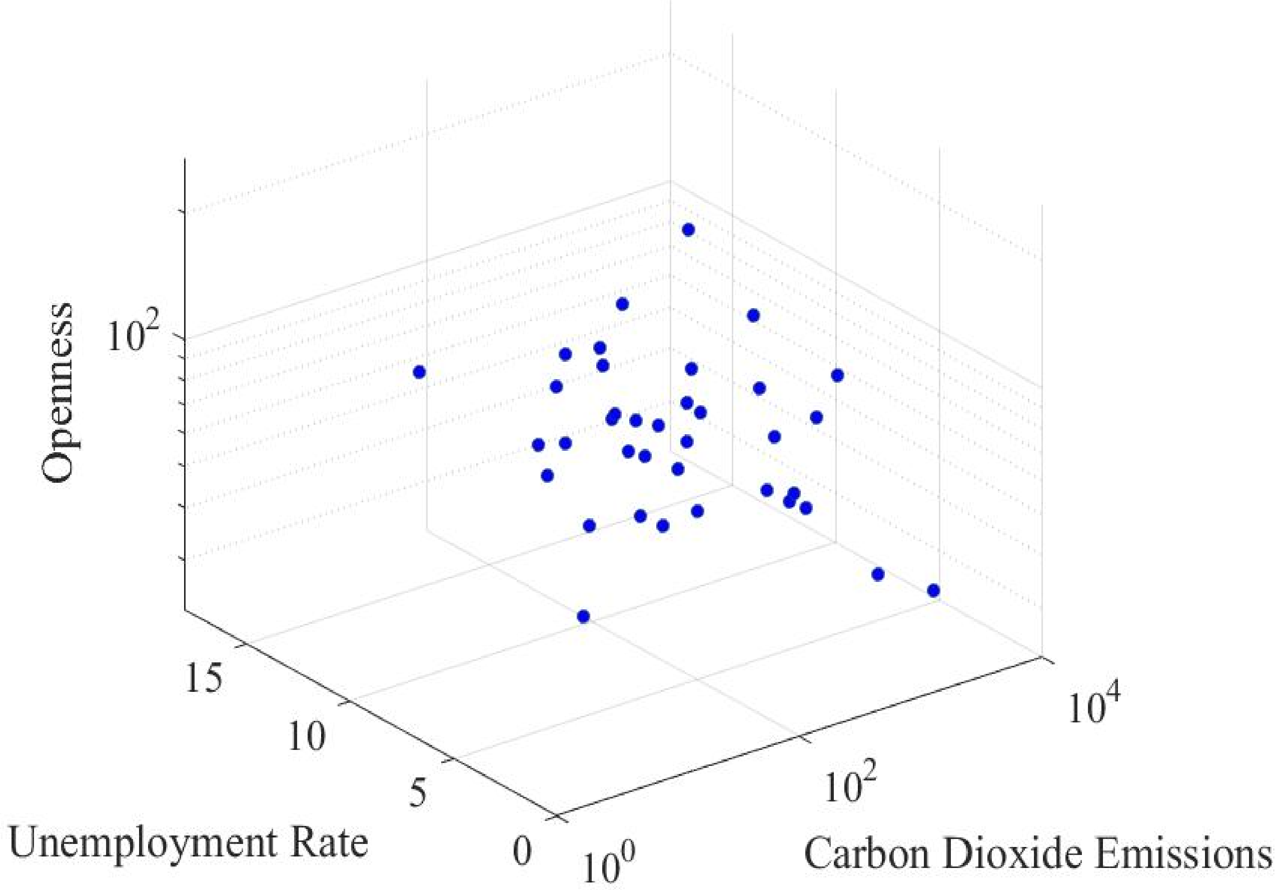
- Wang and Ouattara (2020)

  Closed economy, static model, duopoly, Nash Bargaining.

- Yip(2018)

  Empirical paper, individual level data.

An Employment Double-Dividend Hypothesis and Trade Openness: Data (37 OECD countries in 2019)



Openness: defined as the sum of exports and imports of goods and services relative to GDP.

Our Approach

Nishiyama et al. (2021)

Felbermayr et al. (2011)+Environment.

Felbermayr et al. (2011)

- Heterogeneous firm productivity (Melitz, 2003ECMA).
- Search and matching model of Pissarides (2000).

Openness and Environment

- Kreickemeier and Richter (2014)

Trade liberalization→aggregate domestic output↑, domestic emissions↓ and ambiguous impacts on the level of pollution when local pollution from the other country is considered.

Differences: No welfare analysis; No unemployment.

Openness, Environment and Unemployment

- Sugiyama and Saito (2016)

Small open economy, two-good and two-sector, skilled and unskilled labors, fair wage effort hypothesis, welfare.

Differences: No firm heterogeneity.

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Overview

- n+1symmetric countries.
- Final-goods firms and Immediate-goods firms.
- Pollution.
- Labor is the sole factor of production in inelastic supply L for each country
- Labor is immobile across countries.

Final-Goods Firms

- Final-goods firms face a price t > 0 or an emissions tax for each unit of emissions that they release.
- Minimize their cost

$$\min_{Z,X} C(Z,X) = tZ + P_X X, \qquad (1)$$

subject to the following technology:

$$\mathrm{Y} = Z^{\alpha} X^{1-\alpha}, X = \left(M^{-\frac{1}{\sigma}} \int_{\omega \in \Omega} q_D(\omega)^{\frac{\sigma-1}{\sigma}} d\omega + nM^{-\frac{1}{\sigma}} \int_{\omega \in \Omega} q_{EX}(\omega)^{\frac{\sigma-1}{\sigma}} d\omega \right), \qquad (2)$$

(ω:varieties, Z: pollution, Y :final good, P_X :the price of X, M: the mass of available intermediate goods, $q_i(\omega)$: intermediate goods $(i = D; EX)$, Ω: the set of varieties, $\alpha \in (0,1)$:the share of emission charges in the value of output, and $\sigma > 1$:the elasticity of substitution between varieties).

Final-Goods Firms(2)

- From (1)and (2) we obtain optimal distribution ratio of Z and X:

$$\frac{Z}{X}=\frac{AP_X}{t}, \qquad A\equiv\frac{\alpha}{1-\alpha}.$$

- Therefore, we get

$$X=\left(\frac{t}{AP_X}\right)^{\alpha}Y, \qquad Z=\left(\frac{t}{AP_X}\right)^{\alpha-1}Y. \tag{3}$$

- The price index is

$$P_X = \left(M^{-1} \int_{\omega \in \Omega} p_D(\omega)^{1-\sigma} d\omega + n M^{-1} \int_{\omega \in \Omega} p_{EX}(\omega)^{1-\sigma} d\omega \right)^{\frac{1}{1-\sigma}}, \tag{4}$$

($p_i(\omega)$:the price of varietyω).

- Following Egger and Kreickemeier (2009) and Felbermayr et al. (2011), we choose X as our numéraire, so that P_X = 1 in what follows.
- The household's demand for each varietyω is then given by:

$$q_i(\omega) = (p_{i(\omega)})^{-\sigma} \frac{X}{M} . \tag{5}$$

Intermediate-goods Firms: Optimal Pricing

- Maximize their profits

$$\max_{p_D(\varphi),p_{EX}(\varphi)} \begin{matrix} p_D(\varphi)q_D(\varphi) - wl_D(\varphi) - f_D + \\ I(\varphi)n[p_{EX}(\varphi)q_{EX}(\varphi) - wl_{EX}(\varphi) - f_{EX}] \end{matrix}, \quad (6)$$

subject to the household's demand (4) and their production functions

$$q_D(\varphi) = \varphi l_D(\varphi), \qquad \tau q_{EX}(\varphi) = \varphi l_{EX}(\varphi) \quad (7)$$

($\varphi > 0$:firm productivity, w: the wage, $l_i(\varphi)$:labor, f_D :a fixed production cost, f_{EX} :a fixed exporting cost, $I(\varphi)$:an indicator function(that equals 1 if a rm exports and 0 otherwise),

$\tau > 1$:iceberg variable costs of trade (units of each variety must be exported for one unit to arrive in the foreign country).

- The optimal pricing rules are:

$$p_D(\varphi) = \left(\frac{\sigma}{1-\sigma}\right)\frac{w}{\varphi}, p_{EX}(\varphi) = \tau\left(\frac{\sigma}{1-\sigma}\right)\frac{w}{\varphi}. \quad (8)$$

Thus, $p_{EX}(\varphi) = \tau p_D(\varphi)$, $q_{EX}(\varphi) = \tau^{-\sigma} q_D(\varphi)$, $r_{EX}(\varphi) = \tau^{1-\sigma}\, r_D(\varphi)$.

Intermediate-goods Firms

・Firm profits in each market equal variable profits minus the relevant fixed cost:

$$\pi_D(\varphi) = \frac{r_D(\varphi)}{\sigma} - f_D, \pi_{EX}(\varphi) = \frac{r_{EX}(\varphi)}{\sigma} - f_{EX}. \tag{9}$$

・Aggregate revenue is

$$R(l;\varphi) = \left(\frac{X}{M}\right)^{\frac{1}{\sigma}} \left(\varphi l(\varphi)\right)^{\frac{\sigma-1}{\sigma}} (1 + I(\varphi) n \tau^{-\sigma}) \tag{10}$$

The Labor Market: Search and Matching model

- A matching function:$M(v;\ u) = \Lambda v^{1-\xi} u^{\xi}$

  ($\Lambda > 0, \xi \in (0,1), v$:vacancy rate u:unemployment rate).

- Labor market tightness:$\theta \equiv \frac{v}{u}$

  (vacant jobs become filled is given by $m(\theta) = \Lambda\theta^{-\xi}$).

- Unemployed workers receives is $b\overline{w}$ during search.

  $b \in (0,1)$:unemployment insurance benefits, $\overline{w}$:average wage.

The Labor Market: The Value of Firm

・A firm maximizes its value $J(l;\varphi)$ subject to (10) and the evolution of employment:

$$l' = l - \varsigma l + m(\theta)v = (1-\varsigma)l + m(\theta)v$$

(l' :employment in the next period, ς:the job destruction rate),

・The value of firms:

$$J(l;\varphi) = \max_{v,l} \quad \frac{1}{1+r}\left(R - w(l;\varphi)l + s - cv - f_D + I(\varphi)n[s - f_{EX}] + (1-\delta)J(l';\varphi)\right)$$

(r :the real interest rate, c:hiring cost, s: hiring subsidy, $\delta \in (0,1)$:bad shock).

・The first-order condition for v:

$$\frac{c}{m(\theta)} = (1-\delta)\frac{\partial J\,(l';\varphi)}{\partial l'}. \qquad (11)$$

The Labor Market: Nash Bargaining Solution

- Let us consider a steady state in which $l = l'$ In this case, so we rewrite (11):

$$\frac{\partial R(z,l;\varphi)}{\partial l} = \frac{\partial w(l;\varphi)}{\partial l} l + w(l;\varphi) + \frac{c}{m(\theta)}\left(\frac{r+\Delta}{1-\varsigma}\right) \qquad (12)$$

($\Delta = \delta + \varsigma(1-\delta)$:is the real job destruction rate adjusted by δ).

- the Nash bargaining solution :

$$\left(1-\beta\right)(E-U) = \beta\left(\frac{\partial J\left(z,l;\varphi\right)}{\partial l}\right)$$

($\beta \in (0,1)$:labor's bargaining strength).

- Bellman equation of unemployment is

$$rU(\theta) = b\overline{w} + \theta m(\theta)(E-U) = bw + \theta\left(\frac{\beta}{1-\beta}\right)\left(\frac{c}{1-\delta}\right) \qquad (13)$$

The Labor Market: Equilibrium condition

- We can obtain the *wage equation* from (13):

$$w = B\left(\frac{c}{1-\delta}\right)\left(\frac{r+\Delta}{m(\theta)}+\theta\right), B \equiv \left(\frac{\beta}{1-\beta}\right)\left(\frac{1}{1-b}\right) \tag{14}$$

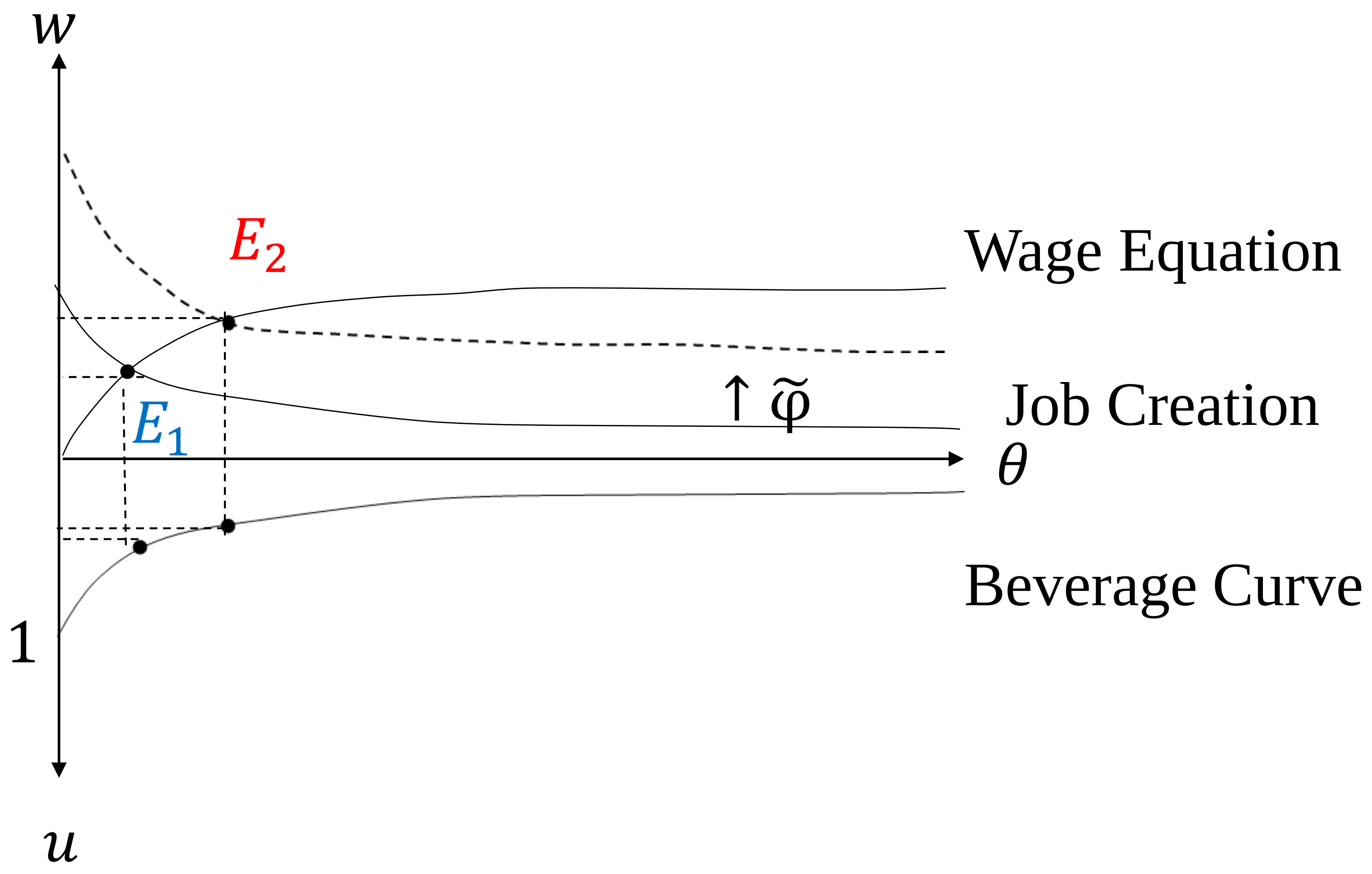
- Next, we define overall weighted average productivity so that $q_D(\tilde{\varphi})=X/M$ as in Egger and Kreickemeier (2009) and Felbermayr et al. (2011).
- The household's demand (4) then implies $p_D(\tilde{\varphi}) = 1$ as $P_X = 1$.
- The *job creation condition*:

$$w(\varphi) = \left(\frac{\sigma-1}{\sigma-\beta}\right)\tilde{\varphi} - \frac{c}{m(\theta)}\left(\frac{r+\Delta}{1-\delta}\right). \tag{15}$$

- The *Beverage curve*:

$$u(\theta) = \frac{\Delta}{\Delta+\theta m(\theta)}. \tag{16}$$

Equilibrium in the labor market with search frictions



Productivity Cutoffs

- There is a large pool of prospective entrants.
- Prior to entry, firms are identical.
- To enter, they must pay a sunk entry cost of fe. Once fe is paid, a firm draws its productivity $\varphi > 0$ from a common distribution. $g(\varphi)$ that has a continuous cumulative distribution $G(\varphi)$.
- If a firm produces, it then faces a constant probability $\delta \in (0,1)$ of a bad shock in every period.

We assume a Pareto distribution:

$$\mathrm{G}(\varphi) = 1 - (\varphi)^{-k}, g(\varphi) = k\varphi^{-(k+1)}, k > (\sigma - 1)\,, \qquad (17)$$

($k > 1$: the shape parameter; lower k means greater dispersion in φ) .

Productivity Distribution

A zero-profit cutoff(ZPC) productivity :

$$\pi(\varphi_i^*) = 0 \; or \;\; r_i = (\varphi_i^*) = \sigma f_i.$$

Their relationship is thus:

$$\varphi_{EX}^* = \tau \left(\frac{f_{EX}}{f_D}\right)^{\frac{1}{\sigma-1}} \varphi_D^*.$$

(The ex post productivity distributions $\mu_i(\varphi)$ in the domestic and export markets are $\mu_i(\varphi) = g(\varphi)/[1 - G(\varphi_i^*)]$; $[1 - G(\varphi_D^*)]$is the probability of successful entry.

As a result, the probability of exporting χ is given by

$$\chi \equiv [1 - G(\varphi_{EX}^*)]/[1 - G(\varphi_D^*)]).$$

The Firm Productivity

- M_D:the mass of producing firms in the domestic market, $M_{EX} = \chi M_D$:the mass of exporting firms.
- The total mass of firms$M = M_D + nM_{EX} = M_D + n\chi M_D = M_D(1 + n\chi)$.

From(5) and (11), We obtain a weighted average of weighted-average productivities in the domestic and export markets:

$$\tilde{\varphi} = \left[\left(\frac{1}{1+n\chi}\right)(\tilde{\varphi}_D^{\sigma-1} + n\chi\tau^{1-\sigma}\tilde{\varphi}_{EX}^{\sigma-1})\right]^{\frac{1}{\sigma-1}}, \tilde{\varphi}_i^{\sigma-1} \equiv \int_{\varphi_i}^{\infty} \varphi^{\sigma-1}\mu_i(\varphi)d\varphi. \qquad (18)$$

- Pareto productivity distribution, $\tilde{\varphi}_i$ can be evaluated as: $\tilde{\varphi}_i$=$\left(\frac{k}{k-(\sigma-1)}\right)^{\frac{1}{\sigma-1}}\varphi^*$

And this allows us to find:

$$\tilde{\varphi} = \left(\frac{1 + n\tau^{-k}(\frac{f_{EX}}{f_D})^{\frac{-k+(\sigma-1)}{\sigma-1}}}{1 + n\tau^{-k}(\frac{f_{EX}}{f_D})^{\frac{-k}{\sigma-1}}}\right)^{\frac{1}{\sigma-1}} \tilde{\varphi}_D. \qquad (19)$$

ZPC Condition and FE Condition

- The ZPC Condition is

$$\Pi_i(\tilde{\varphi}_i) = \{(1+r)f_i - (1-\delta)s\}\left\{\left(\frac{\tilde{\varphi}_i}{\varphi_i^*}\right)^{\sigma-1} - 1\right\}. \tag{20}$$

- And FE condition is:

$$\frac{f_E}{1-G(\varphi_D^*)} = \frac{\widetilde{\Pi}}{r+\delta}.$$

- ZPC Productivity is:

$$\varphi_D^* = \left(\frac{(\sigma-1)}{f_E(r+\delta)[k-(\sigma-1)]}\right)^{\frac{1}{k}} \times \begin{bmatrix} (1+r)f_D\left(1+n\tau^{-k}\left(\frac{f_{EX}}{f_D}\right)^{\frac{-k+(\sigma-1)}{\sigma-1}}\right) - \\ (1-\delta)s\left(1+n\tau^{-k}\left(\frac{f_{EX}}{f_D}\right)^{\frac{-k}{\sigma-1}}\right) \end{bmatrix}^{\frac{1}{k}} \tag{21}$$

ZPC Condition and FEC Condition (2)

Therefore the average productivity level:

$$\tilde{\varphi} = \left[\left(\frac{k}{k-(\sigma-1)}\right)\left(\frac{1+n\tau^{-k}(\frac{f_{EX}}{f_D})^{\frac{-k+(\sigma-1)}{\sigma-1}}}{1+n\tau^{-k}(\frac{f_{EX}}{f_D})^{\frac{-k}{\sigma-1}}}\right)\right]^{\frac{1}{\sigma-1}} \varphi_D^*. \qquad (22)$$

Aggregation

Equilibrium in the labor market implies:

$$(1-u)L = \int_{\varphi_D^*}^{\infty} l_D(\varphi)\, M_D(\varphi)\mu_D(\varphi)d\varphi + n\int_{\varphi_{EX}^*}^{\infty} l_{EX}(\varphi)\, M_{EX}(\varphi)\mu_{EX}(\varphi)d\varphi \quad (23)$$

$$= l_D(\tilde{\varphi}_D)M.$$

The equilibrium total mass of firms:

$$M = \frac{(1-u)L}{l_D(\tilde{\varphi})} = \frac{(1-u)L\tilde{\varphi}}{q_D(\tilde{\varphi})} \quad (24)$$

From(23), the rest of aggregate variables:

$$X = M\, q_D(\tilde{\varphi}), Y = \left(\frac{A}{t}\right)^{\alpha} X, \mathrm{Z} = \left(\frac{A}{t}\right)^{1-\alpha} Y \quad (25)$$

Government and a Hiring Subsidy

・Assumption 1:The government runs a balanced budget in every period.

・Assumption 2:the government does not give s to firms that are hit by a bad shock δ.

・ A balanced budget:

$$tZ = s(1 - \delta)M. \tag{26}$$

・From(25)and (26),

$$s(\tau, n, \alpha) = \left[\frac{A(\alpha)}{1 - \delta}\right] q_D(\tilde{\varphi}). \tag{27}$$

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Trade Liberalization: Preliminaries

- α↓ =environmental technological progress↑.
- As in Melitz (2003), trade liberalization (trade costτ increase in the number of trading partners n) leads to a rise in φ_D^*:

$$\frac{\partial \varphi_D^*}{\partial \tau} < 0, \frac{\partial \varphi_D^*}{\partial n} > 0\,, \boldsymbol{\frac{\partial \varphi_D^*}{\partial \alpha} < 0}.$$

- Lower α →demand for final-goods firms↑→revenues↑
  →Profits of intermediate-goods firms↑

➡the entry of new firms into the markets↓→ φ_D^*↑

Proof of Shifting for the Job Creation Curve

- A response of $\tilde{\varphi}$ that shifts the job creation curve ：

$$\frac{\partial \tilde{\varphi}}{\partial \tau} = \left(\frac{1}{\sigma - 1}\right) \underbrace{\frac{\partial q_D(\tilde{\varphi})/\partial \tau}{q_D(\tilde{\varphi})}}_{(-)} \cdot \frac{\tilde{\varphi}}{\varphi_D^*} + \frac{\partial \varphi_D^*}{\partial \tau} \cdot \frac{\tilde{\varphi}}{\varphi_D^*} < 0.$$

$$\frac{\partial \widetilde{\varphi}}{\partial n} > 0 \, , \frac{\partial \widetilde{\varphi}}{\partial \alpha} < 0.$$

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An Employment Double-Dividend Hypothesis

- From (3),(28) and (29), we analyze X,Y, Z for trade liberalization :

$$\frac{\partial X/\partial\tau}{X} = \underbrace{\frac{\partial M/\partial\tau}{M}}_{(?)} + \underbrace{\frac{\partial q_D(\tilde{\varphi})/\partial\tau}{\partial q_D(\tilde{\varphi})}}_{(-)}\begin{cases} < 0, \sigma \in (1,2) \\ \lesseqgtr 0, \sigma > 2 \end{cases}, \tag{30}$$

$$\frac{\partial Y/\partial\tau}{Y} = \frac{\partial X/\partial\tau}{X}\begin{cases} < 0, \sigma \in (1,2) \\ \lesseqgtr 0, \sigma > 2 \end{cases}, \tag{31}$$

$$\frac{\partial Z/\partial\tau}{Z} = \frac{\partial Y/\partial\tau}{Y}\begin{cases} < 0, \sigma \in (1,2) \\ \lesseqgtr 0, \sigma > 2 \end{cases}. \tag{32}$$

An Employment Double-Dividend Hypothesis

- From (3),(28) and (29), we analyze X,Y, Z for Environment:

$$\frac{\partial X/\partial\alpha}{X}=\frac{\partial M/\partial\alpha}{M}<0 \tag{30$'$}$$

$$\frac{\partial Y/\partial\alpha}{Y}=\alpha t\underbrace{\frac{\partial A/\partial\alpha}{A}}_{(+)}+\underbrace{\frac{\partial X/\partial\alpha}{X}}_{(-)}\lesseqgtr 0, \tag{31$'$}$$

$$\frac{\partial Z/\partial\alpha}{Z}=(1-\alpha)t\underbrace{\frac{\partial A/\partial\alpha}{A}}_{(+)}+\underbrace{\frac{\partial Y/\partial\alpha}{Y}}_{(?)}\lesseqgtr 0. \tag{32$'$}$$

An Employment Double-Dividend Hypothesis(2)

Result:

- From,(30) to (32),

$$\text{Trade liberalization}\uparrow\rightarrow\left\{\begin{array}{c}\text{labor supply}(1-u)L\uparrow\\ \text{output per firm}\,q_D(\tilde{\varphi})\uparrow\downarrow\\ \text{ZPC productivity}\,\varphi_D^*\uparrow\\ \text{output per firm}\,q_D(\tilde{\varphi})\uparrow\end{array}\right\}\;X,Y,Z\uparrow\downarrow.$$

- From(30)’ to (32)’,
  Environmental technological progress↑→X↑ but Y,Z↑↓
  (Depending on an emissions tax rises, or environmental regulations become more strict).
- An employment double-dividend hypothesis holds or is rejected.

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Welfare

- Social welfare function is:

$$\mathbb{W} \equiv Y - Z.$$

- About trade liberalization,

$$\frac{\partial \mathbb{W}}{\partial \tau} = \frac{\partial Y}{\partial \tau} - \frac{\partial Z}{\partial \tau}$$

$$= \left(\frac{A}{t}\right)^{\alpha} \left(1 - \left(\frac{A}{t}\right)^{1-\alpha}\right) M \left(\underbrace{\frac{\partial M/\partial \tau}{M}}_{(?)} q_D(\tilde{\varphi}) + \underbrace{\frac{\partial q_D(\tilde{\varphi})}{\partial \tau}}_{(-)}\right) \begin{cases} < 0, \sigma \in (1,2) \\ \lesseqgtr 0, \sigma > 2 \end{cases} \quad (33)$$

Welfare(2)

- About Environmental technological progress,

$$\frac{\partial \mathbb{W}}{\partial \alpha} = \frac{\partial Y}{\partial \alpha} - \frac{\partial Z}{\partial \alpha}$$

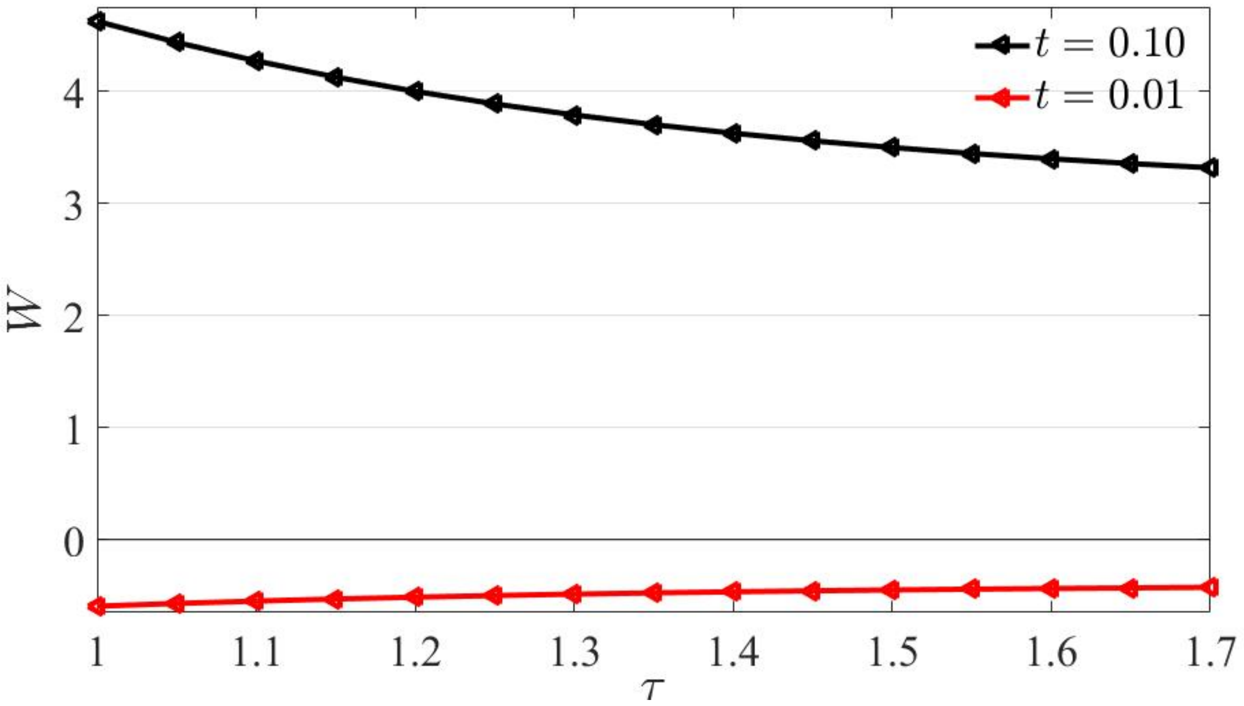
$$= t[\alpha Y - (1-\alpha)Z]\left(2 \times \underbrace{\frac{\partial A/\partial \alpha}{A}}_{(+)} + \underbrace{\frac{\partial X/\partial \alpha}{X}}_{(-)} + \underbrace{\frac{\partial Y/\partial \alpha}{Y}}_{(?)}\right) \gtreqless 0$$

Result: less competitive mkt ($\sigma \in (1,2)$), trade liberalization→$\mathbb{W}\uparrow$

more competitive mkt ($\sigma > 2$), trade liberalization→$\mathbb{W}\uparrow\downarrow$

Environmental technological progress→$\mathbb{W}\uparrow\downarrow$

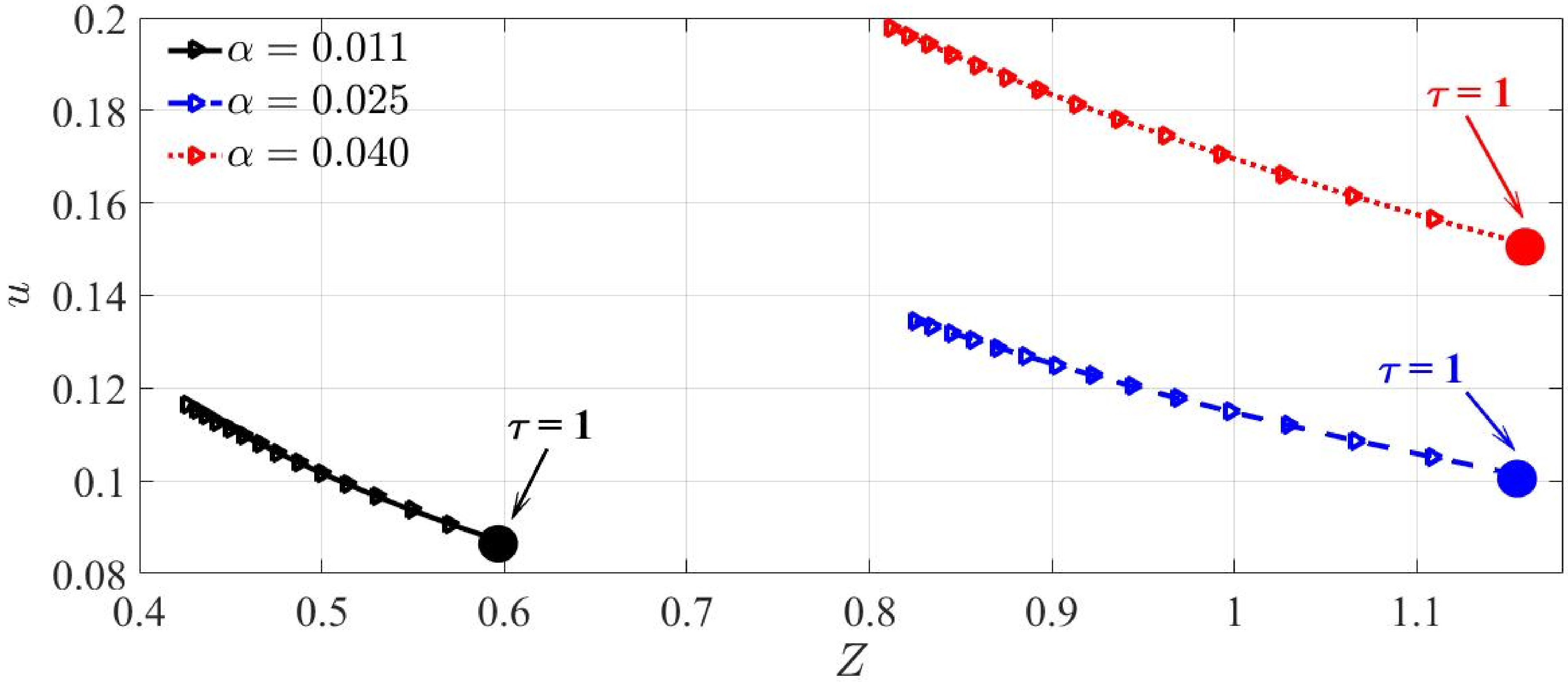
Simulation for Welfare Analysis: Result



- With strict environmental regulations, trade liberalization →welfare↑.
- With weak environmental regulations, trade liberalization →welfare↓.

$$\frac{\partial \mathbb{W}}{\partial t} = \underbrace{\frac{\partial Y}{\partial t}}_{(-)} - \underbrace{\frac{\partial Z}{\partial t}}_{(-)} \lessgtr 0$$

Test an Employment Double-Dividend Hypothesis



The rejection of an employment double-dividend hypothesis for $\alpha = 0.011$ (black solid line), $\alpha = 0.025$ (blue dashed line), and $\alpha = 0.040$ (red dotted line)

Conclusion

- $$\text{Trade liberalization}\uparrow\rightarrow\left\{\begin{array}{c} \text{labor supply}(1-u)L\uparrow \\ \text{output per firm}\,q_D(\tilde{\varphi})\uparrow\downarrow \\ \text{ZPC productivity}\,\varphi_D^{*}\uparrow \\ \text{output per firm}\,q_D(\tilde{\varphi})\uparrow \end{array}\right\} X,Y,Z,\mathbb{W}\uparrow\downarrow$$
- A dirty equilibrium with higher unemployment

⬇

A clean equilibrium with lower unemployment

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Thank you for your time and attention!