Two-factor trade model with monopolistic competition

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Outline

Introduction: main questions

- Impact of differences in endowments of factors on product price and capital price
- Liberalization of trade.
- dumping & reverse-dumping, value of export.
- Relative number of firms and relative GDP.

Introduction: *stylized facts*

- Firms operating in bigger markets have lower markups (Syverson, 2007).
- producers use price-discrimination for different countries (Martin, 2009; Manova and Zhang, 2009)
- dumping (reverse-dumping) means that export price is lower (higher) than domestic price increased by trade cost, and such differences are typical (Bernard et al., 2007)
- import prices capital- and skill-abundant countries much higher prices than imports from another countries (Schott, 2004; Hummels and Klenow, 2005; Hallak, 2006; Hallak and Schott, 2006).

Introduction: *specific cases*

- CES-function predicts constant mark-up and price with number of firm and market size.
- CES predict constant firm size w.r.t market size.
- CES predict same net (without transport cost) prices for domestic and foreign markets.
- Quadratic-utility function "OTT"(Ottaviano, Tabuchi, Thisse, 2002) is still specific case, Berliant (2006): "How can we draw general conclusions... from these models if the conclusions change when the utility functions or functional form of transport cost change? Certainly, examples are a first step in a research program. But they are usually not the last."

Introduction: related literature

- Helpman and Krugman (1987): study trade patterns, "disparities in factors' stock are the main point to understanding international trade patterns";
- Behrens and Murata (2007); Krugman (1979); Ottaviano, Tabuchi, Thisse (2002); Zhelobodko et al. (2012): models with non-CES preferences to study price effects;
- Brander and Krugman (1983): study dumping effect in oligopoly model;
- Greenhut et al. (1987): study dumping effect spatial monopoly model.

Monopistic competition assumptions

1. *Firms produce **distinguish** for consumers varieties.*
2. Each firm produces **a single variety** and chooses its price.
3. The number of firms is **big enough** to ignore impact of each firm on the market.
4. ***Free entry and exit***, firm profit is zero.

Assumptions of the model

- Economy involves two sectors - differentiated "manufacturing" and "agricultural" sector.
- "Agricultural" firms produce homogeneous good with perfect competition and constant rate of return.
- "Manufacturing" firms produce differentiated good with monopolistic competition and increasing rate of return.
- Economy includes (identical in preferences) L "workers" owns one unit of labor and K "capitalists" owns one unit of capital.
- Economy has similar preferences and technologies and includes two countries - Home and Foreign.

Model: consumer's problem

Follow Krugman (1979) and Zhelobodko et al. (2012) we assume nonspecific utility function, so

Consumer's problem:

$$V(\int_0^N u(x_i)di) + A \to \max_{X,A}; \tag{1}$$

budget constraint:

$$\int_0^N p_i x_i di + Ap_a \leq E \tag{2}$$

Here p_a- agricultural good price; A - consumption of agricultural good; E - income of consumer;

$u(.)$ - low-tier utility function; $V(.)$ - upper-tier utility function.

Both utilities strictly increases, strictly concave, thrice continuously differentiable and $u(0) = 0$, $V(0) = 0$.

Model: consumer's problem

- The first-order condition for the consumer's problem implies the inverse demand function for varieties:

$$\mathbf{p}(x_k, \lambda) = \frac{u'(x_k)}{\lambda},$$

which the same for both agents types under quasi-linear utility.

- $\lambda = \frac{1}{V'(\int_0^N u(x_i)di)} > 0$ denotes an analogue of the Lagrange multiplier of the "budget constraint" for sub-optimization problem in with manufacturing only (unlike real budget multiplier equal to 1).
- λ is interpreted as the marginal utility of expenditure for manufacturing or the intensity of competition in manufacturing.

Model: producer's problem

- Agriculture sector produces homogeneous good with marginal cost of one unit of labor, perfect competition and constant return to scale, so price $p_a \equiv 1$.
- Each manufacturing firm faces fixed cost of one unit of capital and marginal cost of c units of labor.
- Labor is intersectorally mobile $\Rightarrow$same wages in both sectors. Without loss of generality we normalized it to $w = 1$.
- Total production cost of output q

$$C(q) = \pi + cq,$$

where π is the price of capital (interest rate); q is output.

- So, income of workers is $E = 1$ and income of capital owners $E = \pi$.

Model: producer's problem

- **Producer's problem** in Home country:

$$(L+K)\mathbf{p}(x_i,\lambda)x_i - (L+K)cx_i - \pi_i \to \max_{x_i}, \tag{3}$$

$q_i \equiv (K+L)x_i$ - output of firm i.

- Since firms have the same product cost they are identical.

Model: producer's problem

Using the FOC we characterize the symmetric profit-maximizing prices:

$$p = \frac{c}{1 - r_u(x)},$$

where

$$r_u(x) \equiv -\frac{xu''(x)}{u'(x)}$$

is the elasticity of the inverse-demand function for variety i and also $r_u(x)$ can be treated as "relative love for variety" (RLV).
Mark-up is:

$$M = \frac{p - c}{p} = r_u(x)$$

Model: equilibrium

- *Symmetric equilibrium is a bundle* (x, p, λ, π, N) satysfying:

$$V'(Ku(x))u'(x) = \frac{c}{1 - r_u(x)}$$

$$\pi = (L + K)(p - c)x$$

$$p = \frac{c}{1 - r_u(x)}$$

$$\lambda = \frac{1}{V'(Ku(x))}$$

$$N = K.$$

Equilibrium: comparative statics of individual consumption

- individual consumption of each variety decreases with number of varieties (supply of capital);
- individual consumption of each variety doesn't depend on labor supply;
- Independence of labor supply is the artifact of the assumption of constant marginal cost.

Equilibrium: comparative statics of price

- Behavior of prices and mark-ups are identical and characterized by $r_u(x) = -\frac{xu''(x)}{u'(x)}$.
- In case increasing RLV ($r_u'(x) > 0$) equilibrium price decreases with number of firms in a country - price decreasing competition.
- In case decreasing RLV ($r_u'(x) < 0$) equilibrium price increases with number of firms in a country - price increasing competition.
- Note that CES-function is boarder-line and equilibrium price and murk-up doesn't depend on market or sector sizes.
- Both price and mark-up are not depend on number of workers.

Equilibrium: comparative statics of interest rate

- Capital price increases with the labor supply (number of workers).
- Behavior of capital price w.r.t. capital supply is ambiguous:

$$\frac{\partial \pi}{\partial K} = \frac{Kcr_u(x)}{1 - r_u(x)} \cdot \frac{\partial x}{\partial K} \cdot \left(\frac{x}{K \frac{\partial x}{\partial K}} + \left(\frac{L}{K} + 1\right) \frac{(2 - r_{u'}(x))}{1 - r_u(x)} \right)$$

- Under sufficiently big workers population interest rate decreases with capital supply, that makes sense.

Equilibrium: comparative statics of welfare

- utility of each worker does not depend on labor supply;
- utility of each capital owner increases with labor supply;
- under price decreasing competition worker's utility increases with capital supply;
- under price decreasing competition and increasing capital price utility of capital owner increases.
- behavior of capital owners' utility is contradictory in more general case:

$$U'(K) = V'(\cdot)u(\cdot) + \pi'_{(K)} - p_{(x)}x_{(K)} - Kp'_{(x)}x_{(K)},$$

- Intuition suggests that increasing as well as decreasing capitalists' utility is native behavior depends on price decreasing/increasing competition and capital price behavior.

Trade

Trade model

Assumptions of the model

- world economy has similar preferences and technologies and includes two countries - Home and Foreign.
- Agricultural good requires zero trade cost.
- $\tau > 1$ is the "iceberg"-type trade cost for manufactured good.
- There is $L = s_a L + (1 - s_a)L$ of identical workers, s_a and $(1 - s_a)$ - the shares of workers in Home and Foreign countries.
- There is $K = sK + (1 - s)K$ of identical capital owners, s and $(1 - s)$ are the shares of capital owners in countries and $s > \frac{1}{2}$.
- Let x^{ij} be the individual consumption of each variety made in country i and consumed in country j, p^{ij} is the price for x^{ij}.
- Let N^H and N^F denote number of firms in Home and Foreign country.

Model: consumer's problem

Consumer's problem in Home country:

$$\max_{X,A}\left[V\left(\int_0^{N_H} u(x_i^{HH})di + \int_{N_H}^{N_H+N_F} u(x_i^{FH})di\right) + A\right]; \tag{4}$$

budget constraint:

$$\int_0^{N_H} p_i^{HH} x_i^{HH} di + \int_{N_H}^{N_H+N_F} p_i^{FH} x_i^{FH} di + Ap_a \leq E \tag{5}$$

Here p_a- agricultural good price; A - consumption of agricultural good; E - income of consumer;
$u(.)$ - low-tier utility function; $V(.)$ - upper-tier utility function.
Both utilities strictly increases, strictly concave, thrice continuously differentiable and $u(0) = 0$, $V(0) = 0$.

Model: consumer's problem

Consumer's problem in Foreign country:

$$\max_{X,A} \left[V\left(\int_0^{N_H} u(x_i^{HF}) di + \int_{N_H}^{N_H+N_F} u(x_i^{FF}) di \right) + A \right]; \qquad (6)$$

budget constraint:

$$\int_0^{N_H} p_i^{HF} x_i^{HF} di + \int_{N_H}^{N_H+N_F} p_i^{FF} x_i^{FF} di + A \leq E \qquad (7)$$

Model: consumer's problem

- The first-order condition for the consumer's problem implies the inverse demand function for varieties:

$$\mathbf{p}(x_k^{HH}, \lambda^H) = \frac{u'(x_k^{HH})}{\lambda^H}, \ \mathbf{p}(x_k^{FH}) = \frac{u'(x_k^{FH})}{\lambda^H}$$

$$\mathbf{p}(x_k^{FF}, \lambda^H) = \frac{u'(x_k^{FF})}{\lambda^F}, \ \mathbf{p}(x_k^{HF}) = \frac{u'(x_k^{HF})}{\lambda^F},$$

which the same for both agents types under quasi-linear utility.

- $\lambda^H = \frac{1}{V'(\int_0^{N_H} u(x_k^{HH})di + \int_{N_H}^{N_H+N_F} u(x_k^{FH})di)} > 0$ denotes an analogue of the Lagrange multiplier of the "budget constraint" for sub-optimization problem in country H with manufacturing only (unlike real budget multiplier equal to 1).
- λ is interpreted as the marginal utility of expenditure for manufacturing or the intensity of competition in manufacturing.

Model: producer's problem

- Agriculture sector produces homogeneous good with marginal cost of one unit of labor, perfect competition and constant return to scale, so price $p_a \equiv 1$.
- Each manufacturing firm faces fixed cost of one unit of capital and marginal cost of c units of labor.
- Labor is intersectorally mobile ⇒same wages in both sectors. Agricultural good requires zero trade cost ⇒same wages in both countries. Without loss of generality we normalized it to $w = 1$.
- Total production cost of output q

$$C(q) = \pi + cq,$$

where π is the price of capital (interest rate); q is output.

- So, income of workers is $E = 1$ and income of capital owners $E = \pi$.

Model: producer's problem

- **Producer's problem** in Home country:

$$(p_i^{HH}(x_i^{HH})-c)(sK+s_aL)x_i^{HH}+(p_i^{HF}(x_i^{HF})-\tau c)((1-s)K+(1-s_a)L)x_i^{HF}-\pi_i^H \to \max_{x_i^{HH},x_i^{HF}}, \quad (8)$$

$q_i^H \equiv (sK+s_aL)x_i$ - output of firm in Home country,
$q_i^F \equiv ((1-s)K+(1-s_a)L)x_i$ - output of firm in Foreign country.

- **Producer's problem** in Foreign country:

$$(p^{FF}(x^{FF})-c)((1-s)K+(1-s_a)L)x^{FF}+(p^{FH}(x^{FH})-c\tau)(sK+s_aL)x^{FH}-\pi_i^F \to \max_{x_i^{FF},x_i^{FH}}, \quad (9)$$

- Since firms have the same product cost they are identical.

Model: producer's problem

Using the FOC we characterize the symmetric profit-maximizing prices:

$$p^{HH} = \frac{c}{1 - r_u(x^{HH})}, \qquad p^{FH} = \frac{\tau c}{1 - r_u(x^{FH})}$$

$$p^{FF} = \frac{c}{1 - r_u(x^{FF})}, \qquad p^{HF} = \frac{\tau c}{1 - r_u(x^{HF})},$$

Mark-up is:

$$M = \frac{p - c}{p} = r_u(x)$$

Model: equilibrium

- *Symmetric equilibrium includes* x^{HH}, x^{FF}, x^{HF}, x^{FH},N^{H}, N^{F}, satysfying:

$$\frac{u'(x^{HH})}{u'(x^{FH})} = \frac{1}{\tau} \cdot \frac{1 - r_u(x^{FH})}{1 - r_u(x^{HH})}$$

$$V'\left[sKu(x^{HH}) + (1-s)\,Ku(x^{FH})\right] u'(x^{HH}) = \frac{c}{1 - r_u(x^{HH})}$$

$$\frac{u'(x^{FF})}{u'(x^{HF})} = \frac{1}{\tau} \cdot \frac{1 - r_u(x^{HF})}{1 - r_u(x^{FF})}$$

$$V'\left[sKu(x^{HF}) + (1-s)\,Ku(x^{FF})\right] u'(x^{FF}) = \frac{c}{1 - r_u(x^{FF})}$$

This system consists of two independent systems with two equations each.

- Capital balance in each country yields:

$$N^{H} = sK; \qquad N^{F} = (1-s)K$$

Equilibrium: behavior of individual consumption

- there is not more than one solution $(x^{HH}, x^{FH}, x^{HF}, x^{FF})$ of the equilibrium system.
- individual consumption of any domestically produced variety is higher than the consumption of any imported variety, i.e. $(x^{HH} > x^{FH},\ x^{FF} > x^{HF})$.
- consumption of a domestic variety is smaller in the country with higher endowment of capital $(x^{FF} > x^{HH})$.
- There exists such critical value $\hat{s} \in (0.5, 1]$ of capital share s of Home, such that orderings of individual consumptions satisfy:
-
$$x^{FF} > x^{HF} > x^{HH} > x^{FH} \quad \text{when } s > \hat{s} \text{ (very asymmetric countries)},$$
-
$$x^{FF} > x^{HH} > x^{HF} > x^{FH} \quad \textit{when } s < \hat{s} \ \ (\textit{close to similar countries}).$$

Equilibrium: comparative statics of prices

- growing transport cost τ makes price p^{ij} of any imported variety increasing when RLV decreases (the change being ambiguous in the opposite case), whereas price p^{ii} of any domestic variety increases (decreases) under increasing (decreasing) RLV.
- growing total world capital K makes all prices p^{ii},p^{ji} of domestic and imported goods decreasing (increasing) under increasing (decreasing) RLV.
- growing country share (s for Home, $(1-s)$ for Foreign) of world capital makes prices p^{ii},p^{ji} of domestic and imported goods in this country decreasing (increasing) under increasing (decreasing) RLV.

Equilibrium: dumping effect

Dumping means that export price is lower than domestic price increased by trade cost.
First possible price orderings under **small asymmetry**:

$$x^{FF} > x^{HH} > x^{HF} > x^{FH}$$

- under **price decreasing competition** behavior **dumping** pricing practiced by each country:

$$p(x^{FF}) > p(x^{HH}) > \frac{p(x^{HF})}{\tau} > \frac{p(x^{FH})}{\tau}$$

- under **price increasing competition** behavior **reverse-dumping** pricing practiced by each country:

$$p(x^{FF}) < p(x^{HH}) < \frac{p(x^{HF})}{\tau} < \frac{p(x^{FH})}{\tau}$$

Equilibrium: dumping effect

Second possible price orderings under **big asymmetry**:

$$x^{FF} > x^{HF} > x^{HH} > x^{FH}$$

- **price decreasing competition** yields dumping used by smaller country and reverse-dumping used by bigger country:

$$p(x^{FF}) > p(x^{HF}) > \frac{p(x^{HH})}{\tau} > \frac{p(x^{FH})}{\tau}$$

- **price increasing competition** yields dumping used by bigger country and reverse-dumping used by smaller country:

$$p(x^{FF}) < p(x^{HF}) < \frac{p(x^{HH})}{\tau} < \frac{p(x^{FH})}{\tau}$$

Equilibrium: value of export

- We study the **impact of difference in capital** among countries. To separate this effect from impacts from heterogeneity in population per se, we consider the *same* populations in both countries: $(sK + s_a L = (1-s)K + (1-s_a)L)$, but still $s > \frac{1}{2}$.
- The value exported from Home country equals to:

$$sK(sK + s_a L)p^{HF}x^{HF}$$

- export from Foreign country is:

$$(1-s)K(sK + s_a L)p^{FH}x^{FH}$$

- Then:

$$sK(sK + s_a L)p^{HF}x^{HF} > (1-s)K(sK + s_a L)p^{FH}x^{FH}$$

The country with **bigger** endowment of capital is **net exporter** of manufacturing good.

Equilibrium: capital price

- *Capital price is* ***smaller*** *in country with* ***bigger*** *endowment of* ***capital****:*

$$\pi^H < \pi^F$$

Equilibrium: relative number of firms and GDP

- Since population being decomposed into workers and capitalists, we seek some disproportional effect in the "monetary" form.
- we use GDP as the measure of the country size:

$$GDP^H = s_a L + sK\pi^H, \qquad GDP^F = (1-s_a)L + (1-s)K\pi^F,$$

where GDP^H is GDP of Home country, GDP^F - GDP of Foreign country.

- Then:

$$\frac{N^H}{N^F} = \frac{s}{1-s} > \frac{s_a L + sK\pi^H}{(1-s_a)L + (1-s)K\pi^F} = \frac{GDP^H}{GDP^F}.$$

The trade equilibrium displays that the country with **advantage in capital** (Home) has **disproportionally lower** relative GDP.

Equilibrium: relative GDP

There are 3 possible situations since $\pi^H < \pi^F$:

- $\pi^H < \pi^F < 1$ then
$$\frac{GDP^H}{GDP^F} < 1$$
- $\pi^H < 1 < \pi^F$ then
$$\frac{GDP^H}{GDP^F} < 1$$
- $1 < \pi^H < \pi^F$ then
$$\frac{GDP^H}{GDP^F} \gtreqless 1$$

Directions of research

- Non-linear marginal cost.
- Heterogeneous firms.
- Agglomeration model.

Thanks

Thank you for attention!