Economies of Scope and Trade

Niklas Herzig

Bielefeld University

May 2017

Overview

1. Literature overview

2. Eckel and Neary (2010)

Literature overview

Product symmetry	Product asymmetry
Symmetric products on both the demand and supply side	*Asymmetric products on the demand side*
Allanson and Montagna (IJIO 2005)	Bernard, Redding and Schott (AER 2010, QJE 2011)
Nocke and Yeaple (IER 2014)	
	Asymmetric products on the supply (cost) side
	Arkolakis, Ganapati and Muendler (2015)
	Mayer, Melitz and Ottaviano (AER 2014)
Cannibalization	
Ju (RIE 2003)	Eckel and Neary (RES 2010) Eckel, Iacovone, Javorcik and Neary (RIE 2016)
Feenstra and Ma (2008)	
Baldwin and Gu (2009)	Eckel, Iacovone, Javorcik and Neary (JIE 2015)
Dhingra (AER 2013)	Qiu and Zhou (JIE 2013)

Overview - Preview of results
Scope adjustment to trade liberalization

types of scope reaction:

- economy-wide reduction
  - Baldwin and Gu (2009)
  - Eckel and Neary (2010)
  - Mayer, Melitz and Ottaviano (2014)
- ambiguous reaction
  - Bernard, Redding and Schott (2011)
- heterogeneous reaction throughout the firm distribution
  - Dhingra (2013)
  - Qiu and Zhou (2013)
  - Nocke and Yeaple (2014)

Eckel and Neary (2010)

Eckel, Carsten and Peter Neary (2010). Multi-Product Firms and Flexible Manufacturing in the Global Economy, *Review of Economic Studies* 77(1), pp. 188-217.

Preferences and Demand

two-tier utility function:

$$U[u(z)] = \int_0^1 u(z)dz \tag{1}$$

with

$$u(z) = a\int_0^N q(i)di - \frac{1}{2}b\left[(1-e)\int_0^N q(i)^2 di + e\left\{\int_0^N q(i)di\right\}^2\right]$$

$q(i)$: consumption of (horizontally diff.) product variety i, $i \in [0, N]$ and
N: measure of diff. varieties produced in each industry z, $z \in [0, 1]$

Eckel and Neary (2010)

utility maximization problem:

$$\max_{q(i)} \quad U[u(z)] \quad \text{subject to}$$

$$\int_0^1 \int_0^N p(i)q(i)didz \leq I$$

$p(i)$: price of variety i and I: individual income

FOC: inverse individual demand function:

$$\lambda p(i) = a - b\left[(1-e)q(i) + e\int_0^N q(i)di\right] \tag{2}$$

λ: Lagrange multiplier (consumer's marginal utility of income)

L (homogeneous) consumers in each of k identical countries, integrated goods markets and free trade (single variety price worldwide) market demand for variety i: $x(i) = kLq(i)$

inverse world market demand function:

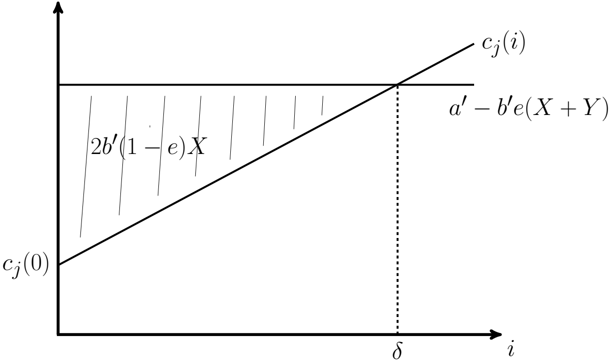
$$p(i) = a' - b'[(1-e)x(i) + eY] \tag{3}$$

$a' \equiv a/\lambda$, $b' \equiv b/\lambda kL$ and $Y \equiv \int_0^N x(i)di$: industry output

Production and Supply
"flexible manufacturing" technology (core competence):
$c_j(i)$: marginal cost of firm j to produce variety i (independent of output, but different across products: $c_j' > 0$ and $c_j(0) = c_j^0$; e.g. linear: $c_j(i) = c_j^0 + \gamma i$)

Eckel and Neary (2010)

Figure 1



Eckel and Neary (2010)

single-stage Cournot game

profit maximization problem:

$$\max_{x_j(i)} \quad \pi_j = \int_0^{\delta_j} [p_j(i) - c_j(i)]\, x_j(i) di - F$$

δ_j: mass of products produced (scope) and F: fixed cost

FOC: (i) scale

$$\frac{\partial \pi_j}{\partial x_j(i)} = p_j(i) - c_j(i) - b' \left[(1-e)x_j(i) + eX_j\right] = 0 \qquad (4)$$

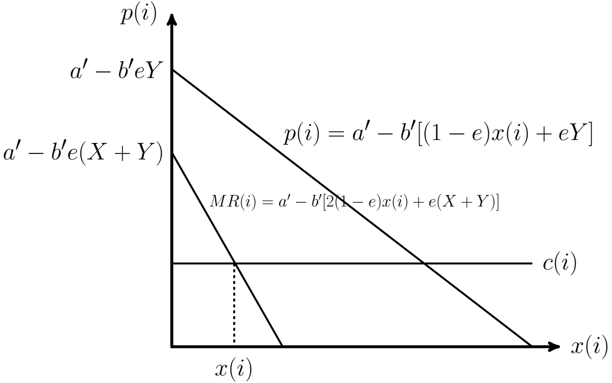
▸ proof

$X_j \equiv \int_0^{\delta_j} x_j(i) di$: firm's aggregate output

$$x_j(i) = \frac{a' - c_j(i) - b'e\,(X_j + Y)}{2b'(1-e)} \qquad (5)$$

Eckel and Neary (2010)

Figure 2



Eckel and Neary (2010)

$$p_j(i) = \frac{1}{2}\left[a' + c_j(i) - b'e(Y - X_j)\right] \qquad (6)$$

(ii) scope

$$\frac{\partial \pi_j}{\partial \delta_j} = [p_j(\delta_j) - c_j(\delta_j)]\, x_j(\delta_j) = 0 \qquad (7)$$

product range: output of the marginal variety (δ_j) zero: $x_j(\delta_j) = 0$

$$c_j(\delta_j) = a' - b'e\,(X_j + Y) \qquad (8)$$

$$p_j(\delta_j) = a' - b'eY$$

labour productivity (LP) of multi-product firms:

labour as the only factor of production and economy-wide and perfectly competitive labour market

unit cost of producing each variety:

$$c(i) = w\gamma(i)$$

Eckel and Neary (2010)

total labour input:

$$l = \int_0^{\delta} \gamma(i)x(i)di$$

$$\frac{d \ln \text{LP}}{d \ln \theta} = \frac{\int_0^{\delta} h(i)\frac{d\,x(i)}{d \ln \theta}di}{\int_0^{\delta} h(i)x(i)di} - \frac{d \ln l}{d \ln \theta} \tag{9}$$

θ: any exogenous variable and $h(i)$: weight of variety i

$$x(i) = \frac{w\left[\gamma(\delta) - \gamma(i)\right]}{2b'(1-e)}$$

$$l = \frac{w\beta(\delta)}{2b'(1-e)} \quad \text{with} \quad \beta(\delta) \equiv \int_0^{\delta} \gamma(i)\left[\gamma(\delta) - \gamma(i)\right]di$$

$$\frac{d \ln \text{LP}}{d \ln \theta} = \frac{\partial \ln \text{LP}}{\partial \ln \delta}\frac{d \ln \delta}{d \ln \theta}$$

▸ proof

Eckel and Neary (2010)

choice of weights $h(i)$:

$$\left.\frac{\partial \ln \mathrm{LP}}{\partial \ln \delta}\right|_{h(i)=\gamma(i)} = \frac{\int_0^\delta \gamma(i) \frac{\partial x(i)}{\partial \ln \delta} di}{\int_0^\delta \gamma(i) x(i) di} - \frac{\partial \ln l}{\partial \ln \delta} = 0$$ ▸ proof

Proposition 1: With given technology, any shock which raises the product range δ

(a) leaves LP unchanged when output changes are marginal cost-weighted,

(b) reduces LP when output is a simple aggregate ▸ proof and

(c) reduces LP but by less when output changes are price-weighted ▸ proof.

Eckel and Neary (2010)

Industry Equilibrium

symmetric Cournot oligopoly with an exogenously given number of firms m in each of k countries

industry output: $Y = kmX$

FOC for scope (rewrite (8)):

$$w\gamma(\delta) = a' - e(1+km)b'X \;\Rightarrow\; \text{scope: } \delta(X)$$

FOC for scale (integrate over (5)):

$$X = \frac{(a' - w\mu'_\gamma)\,\delta}{\triangle_1\; b'} \text{ with } \triangle_1 \equiv 2(1-e)+e\delta(1+km) > 0 \;\text{proof}\; \Rightarrow \text{ scale: } X(\delta)$$

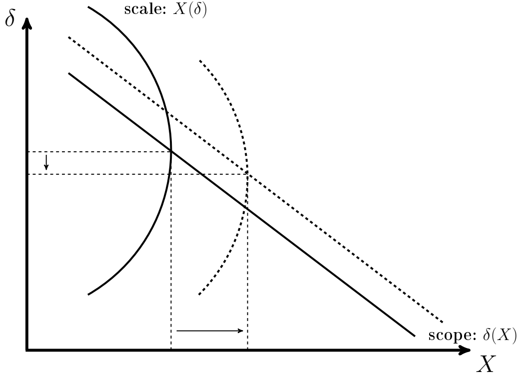
with $\mu'_\gamma \equiv \frac{1}{\delta}\int_0^\delta \gamma(i)di$

$$\frac{d\ln X}{d\ln\delta} = \frac{a' - w\gamma(\delta) - e(1+km)b'X}{a' - w\mu'_\gamma}$$

proof

Eckel and Neary (2010)

Figure 3



Eckel and Neary (2010)

Effects of Globalization

globalization: increase in the number of countries k participating in the global economy

two channels:

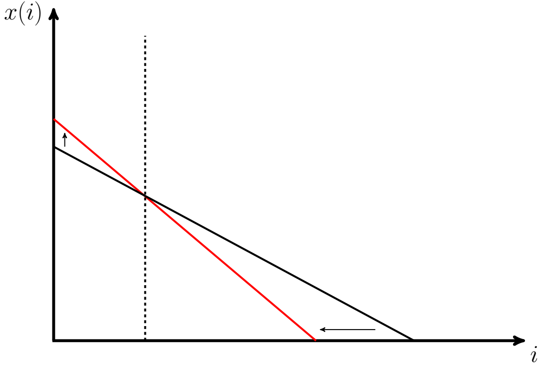
- market-size effect ($L \uparrow$)
- competition effect ($m \uparrow$)

Proposition 2: The *market-size effect* of an increase in k is an equi-proportionate increase in the output of each variety and of total output, but no change in firm scope.

Proposition 3: The *competition effect* of an increase in k is a uniform absolute fall in the output of each variety, coupled with falls in both total firm output and firm scope, but a rise in industry output.

Eckel and Neary (2010)

Figure 4



Eckel and Neary (2010)

full effect:

- on firm output:

$$\frac{d \ln X}{d \ln k} = 1 - \frac{e\delta km}{\Delta_1} \quad \text{▸ proof} \tag{10}$$

where $\Delta_1 - e\delta km = \Delta_0 \ (\equiv 2(1-e) + e\delta) > 0$

- on variety output:

$$\frac{d \ln x(i)}{d \ln k} = 1 - \frac{ekm\alpha(\delta)}{\Delta_1 \left[\gamma(\delta) - \gamma(i)\right]} = \frac{\Delta_0}{\Delta_1} + \left(1 - \frac{\Delta_0}{\Delta_1}\right) \frac{\mu'_\gamma - \gamma(i)}{\gamma(\delta) - \gamma(i)} \quad \text{▸ proof} \tag{11}$$

$\widetilde{\gamma}^{PE}$: labour requirement of the threshold variety whose output is unchanged

$$\widetilde{\gamma}^{PE} = \frac{\Delta_0}{\Delta_1}\gamma(\delta) + \left(1 - \frac{\Delta_0}{\Delta_1}\right) \mu'_\gamma \quad \text{▸ proof}$$

Eckel and Neary (2010)

Proposition 4: The *total effect* of an increase in k is a rise in total output coupled with a fall in scope. Relatively high-cost varieties are discontinued or produced in lower volumes, whereas more is produced of all varieties with average costs or lower.

$\rightarrow$ **"leaner and meaner"-response** of multi-product firms to globalization

Corollary 1: Firm productivity is unaffected by the market-size effect, but rises with the competition effect of an increase in k.

Eckel and Neary (2010)

Globalization and Product Variety

number of varieties per firm $\delta \downarrow$ + number of firms $m \uparrow \rightarrow$ total variety effect?

$N = km\delta$: total number of varieties produced in a symmetric equilibrium

- market-size effect: unaffected
- competition effect: conflicting effects ($m \uparrow$ and $\delta \downarrow$)

$$\frac{d \ln N}{d \ln k} = 1 + \frac{d \ln \delta}{d \ln k} = 1 - \frac{e\delta km}{\triangle_1} \frac{\alpha(\delta)}{\delta \alpha_\delta}$$

Proposition 5: In partial equilibrium, an increase in the number of countries cannot lower the total number of varieties if the function relating costs to varieties has constant curvature, but it may do so if the technology is sufficiently flexible.

Appendix

frequently used notation:

$$\alpha(\delta) = \delta\left[\gamma(\delta) - \mu'_\gamma\right]$$

$$\beta(\delta) = \delta\left[\gamma(\delta)\mu'_\gamma - \mu''_\gamma\right] = \alpha(\delta)\mu'_\delta - \delta\sigma^2_\gamma$$

$$\alpha_\delta = \delta\gamma_\delta$$

$$\beta_\delta = \mu'_\gamma\alpha_\delta$$

Appendix

$$\frac{\partial \pi_j}{\partial x_j(i)} = p_j(i) - c_j(i) + \int_0^{\delta_j} \frac{\partial p_j(i^*)}{\partial x_j(i)} x_j(i^*) di^* = 0$$

$$i = i^* : \frac{\partial p_j(i^*)}{\partial x_j(i)} = -b' \quad \text{and} \quad i \neq i^* : \frac{\partial p_j(i^*)}{\partial x_j(i)} = -b'e$$

$$\frac{\partial \pi_j}{\partial x_j(i)} = p_j(i) - c_j(i) - b' \left[(1-e) x_j(i) + e X_j \right] = 0, \quad X_j \equiv \int_0^{\delta_j} x_j(i^*) di^* \tag{4}$$

back

Appendix

$$\frac{d\ln \mathrm{LP}}{d\ln\theta} = \frac{\partial \ln \mathrm{LP}}{\partial \ln\theta} + \frac{\partial \ln \mathrm{LP}}{\partial \ln\delta}\frac{d\ln\delta}{d\ln\theta}$$

$$I = \psi(\theta)\beta(\delta) \quad \text{and} \quad \frac{\partial \ln I}{\partial \ln\theta} = \frac{\partial \ln I}{\partial\theta}\frac{\partial\theta}{\partial\ln\theta} = \frac{\psi'}{\psi}\theta$$

$$x = \psi(\theta)\left[\gamma(\delta) - \gamma(i)\right] \quad \text{and} \quad \frac{\partial x}{\partial \ln\theta} = \frac{\partial x}{\partial\theta}\frac{\partial\theta}{\partial\ln\theta} = \left[\gamma(\delta) - \gamma(i)\right]\psi'\theta$$

$$\frac{\int_0^\delta h(i)\frac{\partial x}{\partial\ln\theta}di}{\int_0^\delta h(i)x(i)di} = \frac{\int_0^\delta h(i)\psi'(\theta)\theta\left[\gamma(\delta) - \gamma(i)\right]di}{\int_0^\delta h(i)\psi(\theta)\left[\gamma(\delta) - \gamma(i)\right]di} = \frac{\psi'}{\psi}\theta$$

$$\frac{d\ln \mathrm{LP}}{d\ln\theta} = \frac{\partial \ln \mathrm{LP}}{\partial \ln\delta}\frac{d\ln\delta}{d\ln\theta} \qquad \left(\frac{\partial \ln \mathrm{LP}}{\partial \ln\theta} = 0\right)$$

back

Appendix

$$
\begin{aligned}
\left.\frac{\partial \ln \mathrm{LP}}{\partial \ln \delta}\right|_{h(i)=\gamma(i)} &= \frac{\int_0^\delta \gamma(i)\frac{\partial x(i)}{\partial \ln \delta}di}{\int_0^\delta \gamma(i)x(i)di} - \frac{\partial \ln I}{\partial \ln \delta} \\
&= \frac{1}{I}\int_0^\delta \gamma(i)\frac{\partial x(i)}{\partial \ln \delta}di - \frac{\partial \ln I}{\partial \ln \delta} \\
&= \frac{1}{I}\int_0^\delta \frac{\partial \gamma(i)x(i)}{\partial \ln \delta}di - \frac{\partial \ln I}{\partial \ln \delta} \\
&= \int_0^\delta \frac{\partial \ln I}{\partial I}\frac{\partial \gamma(i)x(i)}{\partial \ln \delta}di - \frac{\partial \ln I}{\partial \ln \delta} \\
&= \frac{\partial \ln I}{\partial \ln \delta}\int_0^\delta \frac{\partial \gamma(i)x(i)}{\partial I}di - \frac{\partial \ln I}{\partial \ln \delta} = 0
\end{aligned}
$$

back

Appendix

$$
\begin{aligned}
\left.\frac{\partial \ln \mathrm{LP}}{\partial \ln \delta}\right|_{h(i)=1} = \frac{\partial \ln X}{\partial \ln \delta} - \frac{\partial \ln l}{\partial \ln \delta} &= \frac{\partial \ln \alpha(\delta)}{\partial \ln \delta} - \frac{\partial \ln \beta(\delta)}{\partial \ln \delta} \\
(\text{since } X = \int_0^{\delta} \frac{w\left[\gamma(\delta) - \gamma(i)\right]}{2b'(1-e)} di &= \frac{w}{2b'(1-e)} \delta \left(\gamma(\delta) - \mu'_{\gamma}\right) \\
&= \frac{w\alpha(\delta)}{2b'(1-e)}) \\
&= \frac{\delta \alpha_{\delta}}{\alpha(\delta)} - \frac{\delta \beta_{\delta}}{\beta(\delta)} \\
&= -\frac{\delta^2 \alpha_{\delta} \sigma_{\gamma}^2}{\alpha(\delta)\beta(\delta)} < 0
\end{aligned}
$$

back

Appendix

$$\left.\frac{\partial \ln \mathrm{LP}}{\partial \ln \delta}\right|_{h(i)=p(i)} = \frac{\int_0^\delta p(i) \frac{\partial x(i)}{\partial \ln \delta} di}{\int_0^\delta p(i)x(i)di} - \frac{\partial \ln I}{\partial \ln \delta}$$

$$\begin{aligned}
p(i)x(i) &= \frac{1}{2}\left(a' + w\gamma(i) - b'e(Y - X)\right) \frac{w}{2b'(1-e)} [\gamma(\delta) - \gamma(i)] \\
&= \frac{1}{2}\left(w\gamma(i) + w\gamma(\delta) + 2b'eX\right) \frac{w}{2b'(1-e)} [\gamma(\delta) - \gamma(i)] \\
&= w\left(\frac{1}{2}(\gamma(i) + \gamma(\delta)) + e\frac{\alpha(\delta)}{2(1-e)}\right) \frac{w}{2b'(1-e)} [\gamma(\delta) - \gamma(i)]
\end{aligned}$$

back

Appendix

$$X = \int_0^{\delta} \frac{a' - w\gamma(i) - b'e(X+Y)}{2b'(1-e)} di$$
$$= \frac{1}{2b'(1-e)} \int_0^{\delta} (a' - w\gamma(i) - b'e(1+km)X) di$$

$$X\left(1 + \frac{b'e\delta(1+km)}{2b'(1-e)}\right) = \frac{1}{2b'(1-e)} \int_0^{\delta} (a' - w\gamma(i)) di$$
$$X\left(\frac{2b'(1-e) + b'e\delta(1+km)}{2b'(1-e)}\right) = \frac{\delta}{2b'(1-e)} \left(a' - w\mu'_{\gamma}\right)$$

$$X = \frac{\delta}{b'(2(1-e) + e\delta(1+km))} \left(a' - w\mu'_{\gamma}\right)$$

▸ back

Appendix

$$\ln X = \ln\left(\left(a' - w\mu'_\gamma\right)\delta\right) - \ln\left(\left(2(1-e) + e\delta(1+km)\right)b'\right)$$

$$\mu'_\gamma = \frac{1}{\delta}\int_0^\delta \gamma(i)di$$

$$\frac{d}{d\delta}\mu'_\gamma = \frac{\gamma(\delta)\delta - \int_0^\delta \gamma(i)di}{\delta^2} = \frac{\gamma(\delta) - \mu'_\gamma}{\delta}$$

$$\frac{d\ln X}{d\ln\delta} = \frac{\delta}{\left(a' - w\mu'_\gamma\right)\delta}\left(\left(a' - w\mu'_\gamma\right) + \delta\left(-w\frac{\gamma(\delta) - \mu'_\gamma}{\delta}\right)\right)$$
$$- \frac{\delta}{\left(2(1-e) + e\delta(1+km)\right)b'}\left(eb'(1+km)\right)$$

$$\frac{d\ln X}{d\ln\delta} = \frac{a' - w\gamma(\delta)}{a' - w\mu'_\gamma} - \frac{eb'(1+km)X}{a' - w\mu'_\gamma} = \frac{a' - w\gamma(\delta) - eb'(1+km)X}{a' - w\mu'_\gamma}$$

back

Appendix - Industry Equilibrium Comparative Statics

$$\begin{bmatrix} \triangle_1 & 0 \\ e(1+km) & \frac{2(1-e)\delta\gamma_\delta}{\alpha(\delta)} \end{bmatrix} \begin{bmatrix} d\ln X \\ d\ln\delta \end{bmatrix} = \begin{bmatrix} \triangle_1 \\ e(1+km) \end{bmatrix} d\ln L$$

$$-ekm \begin{bmatrix} \delta \\ 1 \end{bmatrix} d\ln m + \begin{bmatrix} \triangle_0 \\ e \end{bmatrix} d\ln k - \begin{bmatrix} \delta\mu'_\gamma \\ \gamma(\delta) \end{bmatrix} \frac{2(1-e)}{\alpha(\delta)} d\ln w$$

$$d\ln X = d\ln L - \frac{e\delta km}{\triangle_1} d\ln m + \frac{\triangle_0}{\triangle_1} d\ln k - \frac{2(1-e)\delta\mu'_\gamma}{\triangle_1\ \alpha(\delta)} d\ln w$$

$$d\ln\delta = -\frac{e\delta km\alpha(\delta)}{\triangle_1\ \delta\alpha_\delta}(d\ln m + d\ln k) - \frac{2(1-e)\delta\mu'_\delta + \triangle_1\ \alpha(\delta)}{\triangle_1\ \delta\alpha_\delta} d\ln w$$

back

Appendix - Industry Equilibrium Comparative Statics

$$d \ln x(i) = d \ln L - \frac{ekm\alpha(\delta)}{\Delta_1 \left[\gamma(\delta) - \gamma(i)\right]} d \ln m + \left[\frac{\Delta_0}{\Delta_1} + \left(1 - \frac{\Delta_0}{\Delta_1}\right) \frac{\mu'_\gamma - \gamma(i)}{\gamma(\delta) - \gamma(i)}\right] d \ln k - \frac{2(1-e)\gamma(i) - e\delta(1+km)\left[\mu'_\gamma - \gamma(i)\right]}{\Delta_1 \left[\gamma(\delta) - \gamma(i)\right]} d \ln w$$

back

Appendix - Industry Equilibrium Comparative Statics

$$
\begin{aligned}
0 &= \frac{\Delta_0}{\Delta_1} + \left(1 - \frac{\Delta_0}{\Delta_1}\right) \frac{\mu'_\gamma - \gamma(i)}{\gamma(\delta) - \gamma(i)} \\
(\gamma(i) - \gamma(\delta)) \frac{\Delta_0}{\Delta_1} &= \left(1 - \frac{\Delta_0}{\Delta_1}\right) (\mu'_\gamma - \gamma(i)) \\
\widetilde{\gamma}^{PE} = \gamma(i) &= \frac{\Delta_0}{\Delta_1} \gamma(\delta) + \left(1 - \frac{\Delta_0}{\Delta_1}\right) \mu'_\gamma
\end{aligned}
$$

back