Vertical Product Differentiation and Credence Goods: Mandatory Labeling and Gains from International Integration

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Motivation

■ **Goods increasingly differentiated by process attributes**

■ **Consumers unable to verify claims about attributes, i.e., a form of *credence good* (Darby and Karni, 1973)**

■ **Labeling possible, but there are implementation issues:**

- **discrete vs. continuous labels**

- **voluntary vs. mandatory**

- **exclusive vs. non-exclusive**

- **harmonized vs. mutual recognition**

■ **Examine trade implications of choices in context of model of *vertical* product differentiation**

Model

■ *Consumers, firms and quality*

Consumers have unit demand for quality-differentiated good, consumer utility is:

(1) $\qquad U = u(y - p)$,

where $u \in [\underline{u}, \infty]$ and $\underline{u} > 0$ is minimum quality-standard

Income uniformly distributed on interval $[a, b]$, and size of population is s

Firms produce single differentiated good with zero production costs and a fixed, quality-dependent cost, $F(u)$, sunk by firm after entry:

$$F(u) = \varepsilon + \alpha(u - \underline{u})^2 \, , \; \varepsilon \text{ and } \alpha > 0$$

■ *Game structure*

3-stage game: (1) entry/no-entry; (2) choice of quality; (3) price

Invoke sub-game perfection and Bertrand-Nash competition

■ *Labeling policy*

Public certifiers perfectly monitor and communicate quality of individual firms *ex ante*, total cost of certifying and labeling being:

$$I^j(u) = I^j \text{ for } u > \underline{u}, \quad j \in \{t, d\}, \text{ and } I^t \geq I^d$$

where t = continuous, and d = discrete labeling

No economies of scale in public certification, and no variable costs of labeling

■ *Entry and number of firms*

Assume:

(2) $\qquad 4a > b > 2a$ **or** $b/4 < a < b/2.$

ensuring *covered* market of 2 firms with quality levels $0 < \underline{u} \leq u_1 < u_2$

■ *Price equilibrium*

y' is income at which consumer is indifferent to buying either high or low-quality good:

(3) $\qquad y' = (1 - r)p_1 + rp_2,$

where $r = u_2 / (u_2 - u_1)$**, and** p_q **is price of good,** $q = 1,2$**, and if** $p_1 = y$**, consumer indifferent between good of quality** u_1 **and no good**

Firms' profits are:

(4) $\qquad \pi_1 = sp_1(y' - a) - F(u_1)$

(5) $\qquad \pi_2 = sp_2(b - y') - F(u_2)$

Bertrand-Nash equilibrium prices being:

(6) $\qquad p_1 = \dfrac{b - 2a}{3(r - 1)}$

(7) $\qquad p_2 = \dfrac{2b - a}{3r}$

(6) and (7) holding if $p_1 \le a$, so that $u_1 \ge \hat{u}_1(u_2) = \dfrac{u_2(b - 2a)}{b + a}$

- *In covered market, equilibrium prices increase in b and $(u_2 - u_1)$*

■ *Autarky Equilibrium with Perfect Information*

Suppose quality is observable, firms' profit functions are:

$$(9) \qquad \pi_1(u_1; u_2) = \frac{s(b-2a)^2(u_2 - u_1)}{9u_1} - F(u_1) \text{ for } u_1 > \hat{u}_1(u_2)$$

$$(10) \qquad \pi_2(u_1; u_2) = \frac{s(2b-a)^2(u_2 - u_1)}{9u_2} - F(u_2) \text{ for } u_2 < \hat{u}_2(u_1)$$

where $\hat{u}_1$ is as defined, and $\hat{u}_2(u_1) = u_1(b+a)/(b-2a)$

● ***Low-quality firm chooses $u_1{}^* = \underline{u}$ in equilibrium***

Follows from differentiating (9):

$$(11) \qquad \frac{\partial \pi_1}{\partial u_1}(u_1; u_2) = -\frac{2s(b-2a)^2}{9}\frac{u_2}{(u_1)^2} - F'(u_1) < 0 \text{ for } u_1 > \hat{u}_1(u_2)$$

High-quality firm's optimal quality decision follows from (10):

$$(12) \qquad \frac{\partial \pi_2}{\partial u_2}(u_1; u_2) = \frac{s(2b-a)^2}{9} \frac{u_1}{(u_2)^2} - F'(u_2) \text{ for } u_2 < \hat{u}_2(u_1)$$

where $\dfrac{\partial^2 \pi_2}{\partial (u_2)^2} = -\dfrac{2s}{9}\left[\dfrac{2b-a}{u_2}\right]^2 \dfrac{u_1}{u_2} - \dfrac{\partial^2 F(u_2)}{\partial (u_2)^2} < 0$

Given $u_1 = \underline{u}$, firm 2's choice of quality induces a covered market:

$$\frac{\partial \pi_2}{\partial u_2}(u_2; \underline{u}) = 0 \text{ for } u_2 < \hat{u}_2(\underline{u})$$

Equilibrium quality in a covered market is implicitly defined by:

$$(13) \qquad u_2{}^* = \left\{ u_2 \left| \frac{s(2b-a)^2}{9} \frac{u_1}{(u_2)^2} - F'(u_2) = 0 \right. \right\}$$

$u_1{}^* = \underline{u}$ and (13) represent the Nash equilibrium in qualities

- **_With perfect information on $u_2{}^*$, profits of both firms increase with b and s_**

This follows from inspection of (9) and (10)

Aggregate consumer welfare in equilibrium is:

(14)
$$W = \int_a^{y'} u_1{}^*(\psi - p_1{}^*)d\psi + \int_{y'}^b u_2{}^*(\psi - p_2{}^*)d\psi$$

- **_As u_2 increases, (i) welfare of consumers purchasing low-quality good decreases, (ii) proportion of consumers purchasing low-quality good declines, and (iii) aggregate consumer welfare increases_**

(i) See utility function (1)

(ii) Differentiate (3) w.r.t u_2, $\dfrac{\partial y'}{\partial u_2} = -\dfrac{2u_1 u_2(2b-a)}{3(u_2-u_1)^3} < 0$

(iii) In aggregate, consumers value quality over price increases

Figure 1: Autarky equilibrium with perfect information
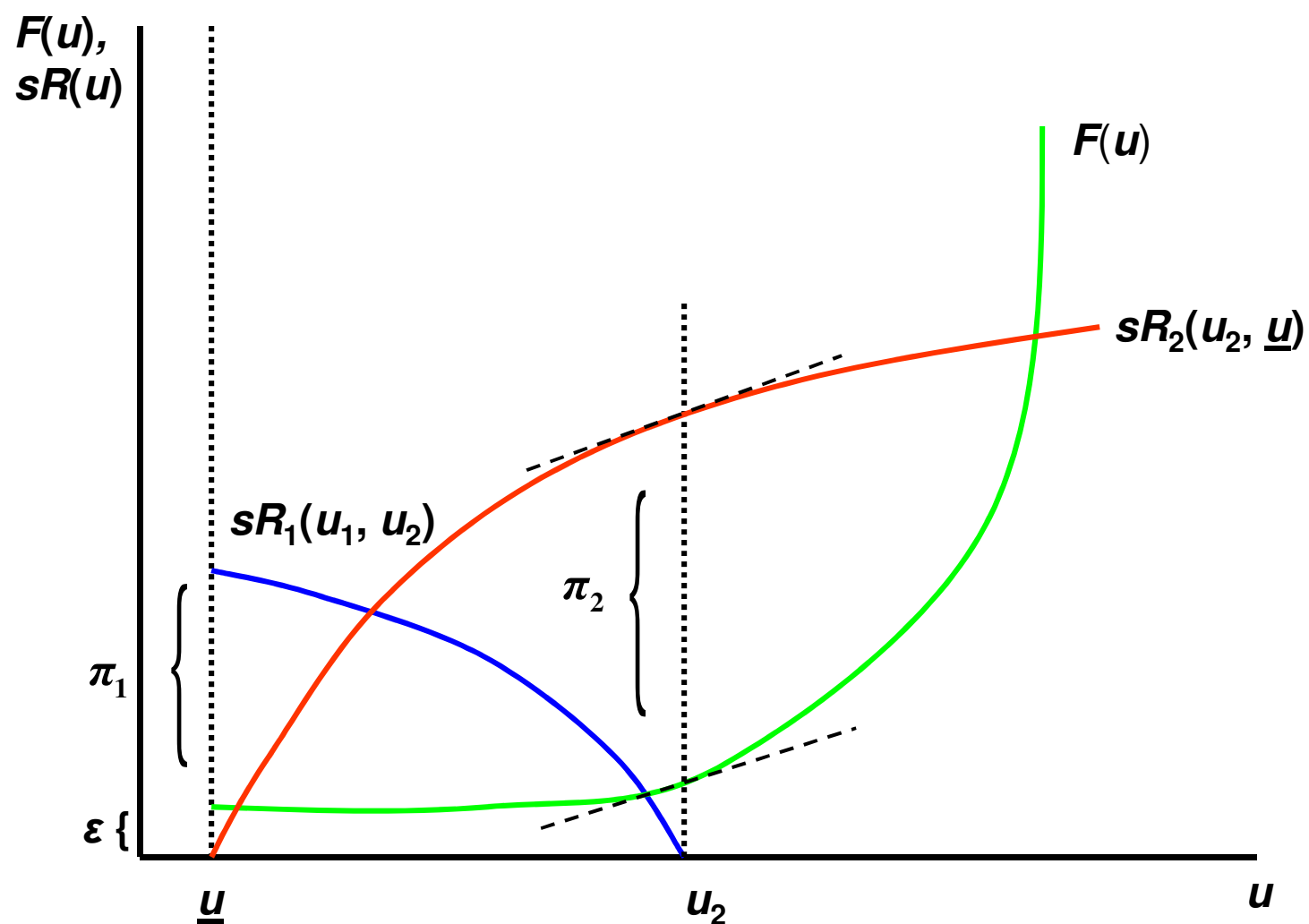
North-North Integrated Equilibrium

■ *Perfect information (PI)*

- two economies, $N=1,2$, with same distribution of income integrate, $a_1=a_2$ and $b_1=b_2$, although may be of differing sizes, i.e., $s^i = s_1 + s_2$

- firms incur additional sunk costs ε^i to enter integrated market, but $\underline{u}_1 = \underline{U}_2$,

- economy supports 2 firms, i.e., 2 firms have to exit, figure 2

- increase in quality of good 2, quality of good 1 remaining the same

■ *Trade with no labeling (XL)*

- sunk cost of entry combined with 3-stage game supports entry of single firm into integrated market producing lowest quality

- price is monopoly outcome given linear demand structure due to assumptions on income distribution

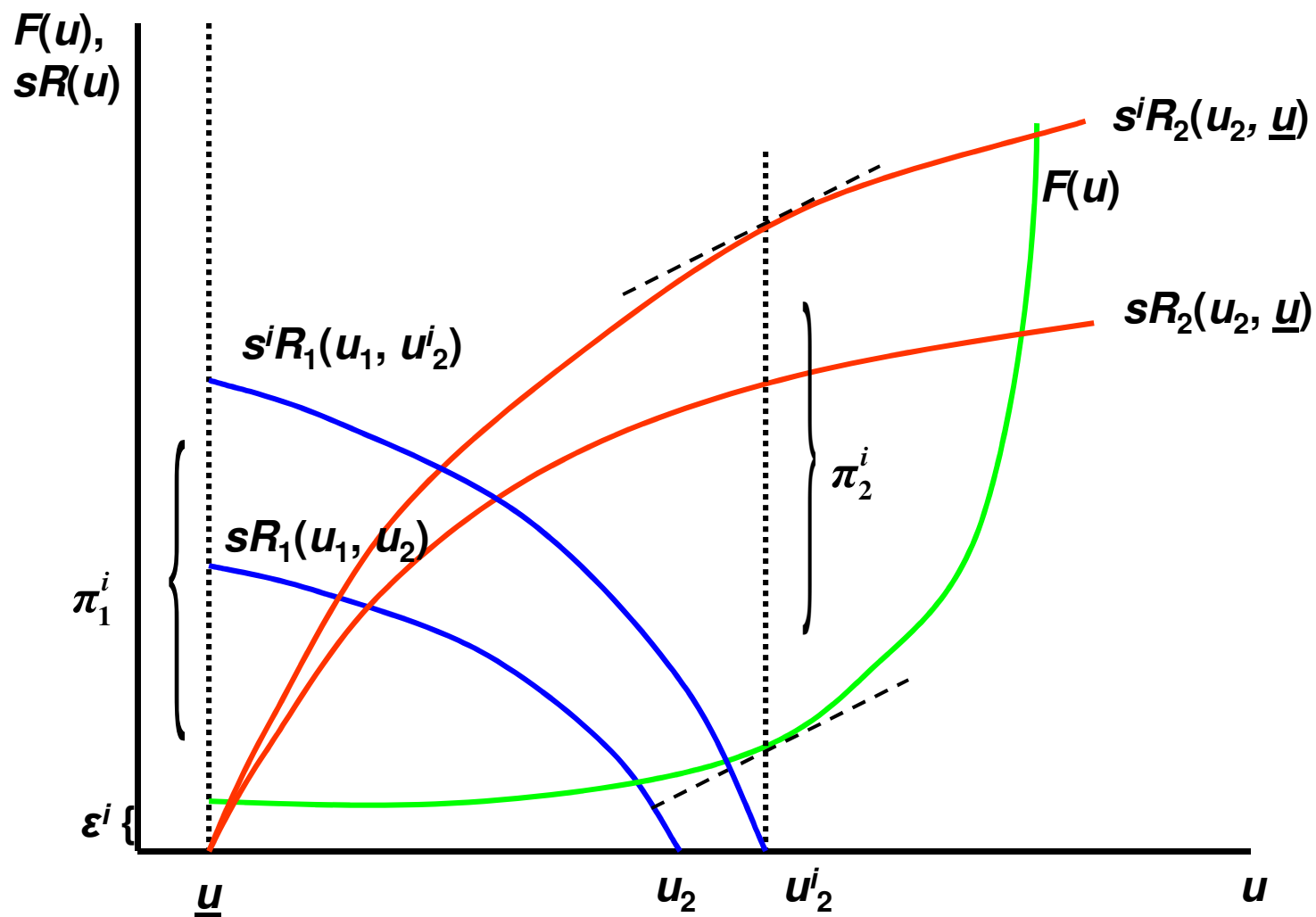**Figure 2: North-North trade equilibrium – *PI* case**

Table 1: Labeling regimes – North/North trade

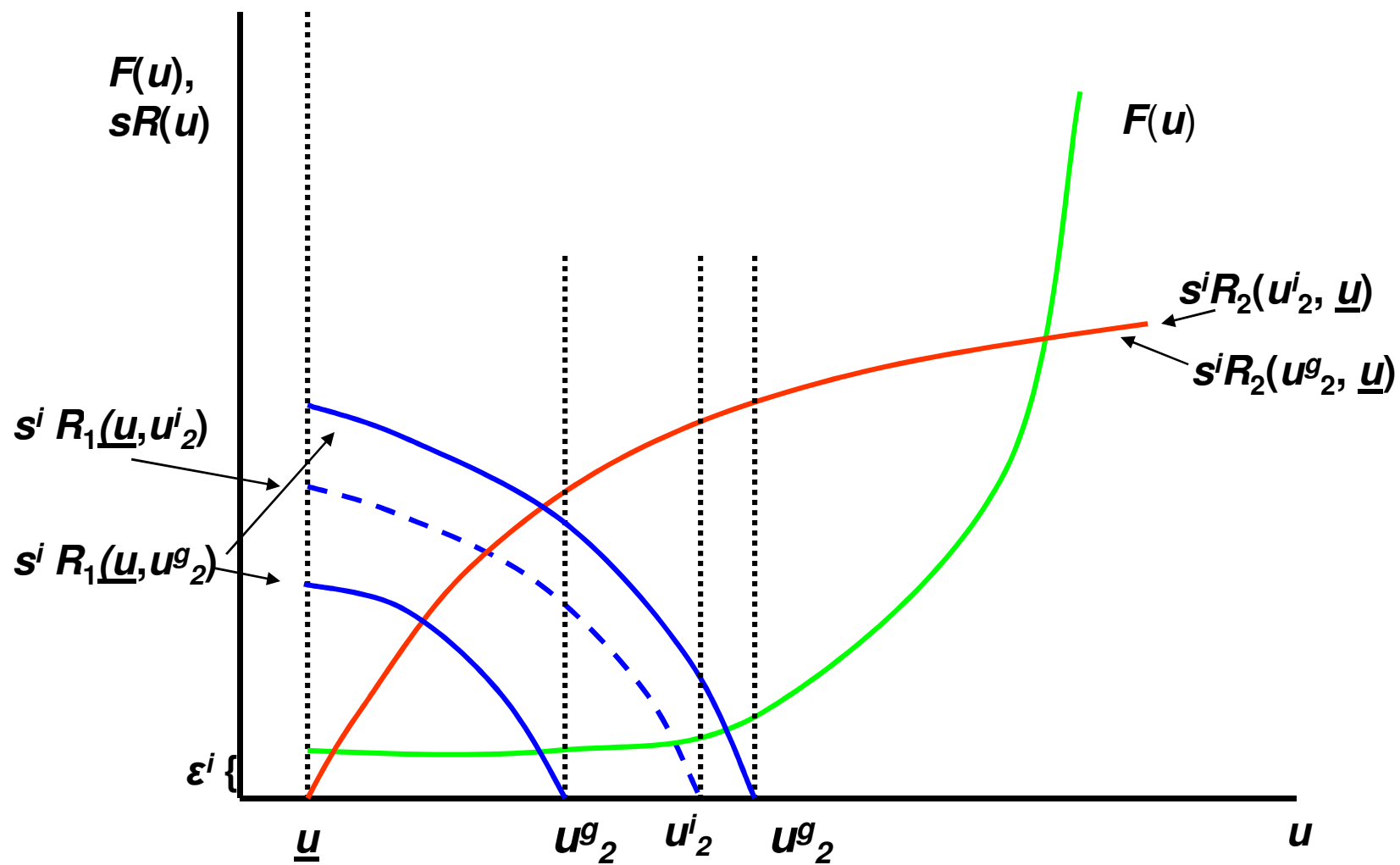|	MEC	MED
Harmonized	Replicates *PI*	May be *XL* (Figure 3)
Mutual recognition	Replicates *PI*	May replicate *PI*

PI – perfect information

XL – no labeling

MEC – mandatory, non-exclusive, continuous

MED – mandatory, exclusive, discrete

Figure 3: Harmonized – *MED* case

$F(u)$,
$sR(u)$

$F(u)$

$s^i R_2(u^i_2, \underline{u})$

$s^i R_2(u^g_2, \underline{u})$

$s^i R_1(\underline{u}, u^i_2)$

$s^i R_1(\underline{u}, u^g_2)$

ε^i {

$\underline{u}$ u^g_2 u^i_2 u^g_2 u

North-South Integrated Equilibrium

■ *Trade equilibrium with overlapping income distributions*

- if two economies, *N* and *S* initially support two goods using same technology, but $a_N > a_S$, and $b_N > b_S$, and $\underline{u}_N > \underline{u}_S$, there will be three goods in integrated equilibrium if, $a_N/2 < a_S < a_N < b_N/2 < b_S < b_N$

- gains from trade occur due to lower prices in equilibrium

- *XL* generates monopoly outcome

- *MEC* replicates *PI*

- harmonized *MED*, one or two firms may be forced from market in equilibrium, but not necessarily with mutual recognition