"Issues in Credence Good Labeling"

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Drawing on:

(1) B. Roe and I.M. Sheldon, "Credence Labeling: Efficiency and Distributional Implications of Several Policy Approaches," *American Journal of Agricultural Economics*, 89 (4) 2007.

(2) I.M. Sheldon and B. Roe, "Vertical Product Differentiation and Credence Goods: Mandatory Labeling and Gains from International Integration," *EconoQuantum*, forthcoming.

(3) I.M. Sheldon and B. Roe, "Public vs. Private Eco-Labeling of Environmental Credence Goods: Maximizing the Gains from International Integration," in review.

Seminar, Tecnológico de Monterrey, Campus Guadalajara
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Motivation

- Goods increasingly differentiated by process attributes, e.g., organic food, sustainable forest management, low emissions electricity
- 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 model of *vertical* product differentiation

Model

- ***Consumers, firms and quality***

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

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

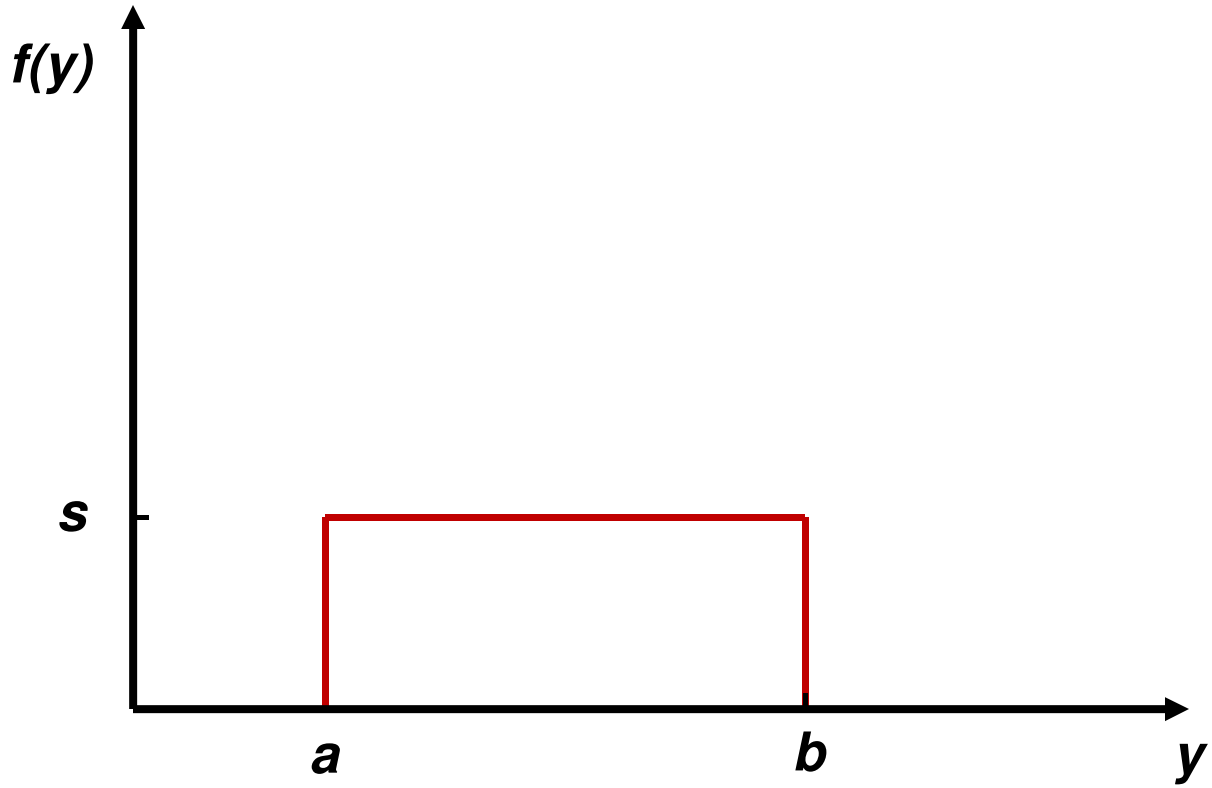
where $u \in [\underline{u}, \infty]$ **and** $\underline{u} > 0$ **is minimum quality-standard**

Income uniformly distributed on interval [*a*, *b*], and size of population is *s* (see Figure 1)

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

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

Figure 1: Income Distribution



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

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

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

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

- ***Price equilibrium***

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

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

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**

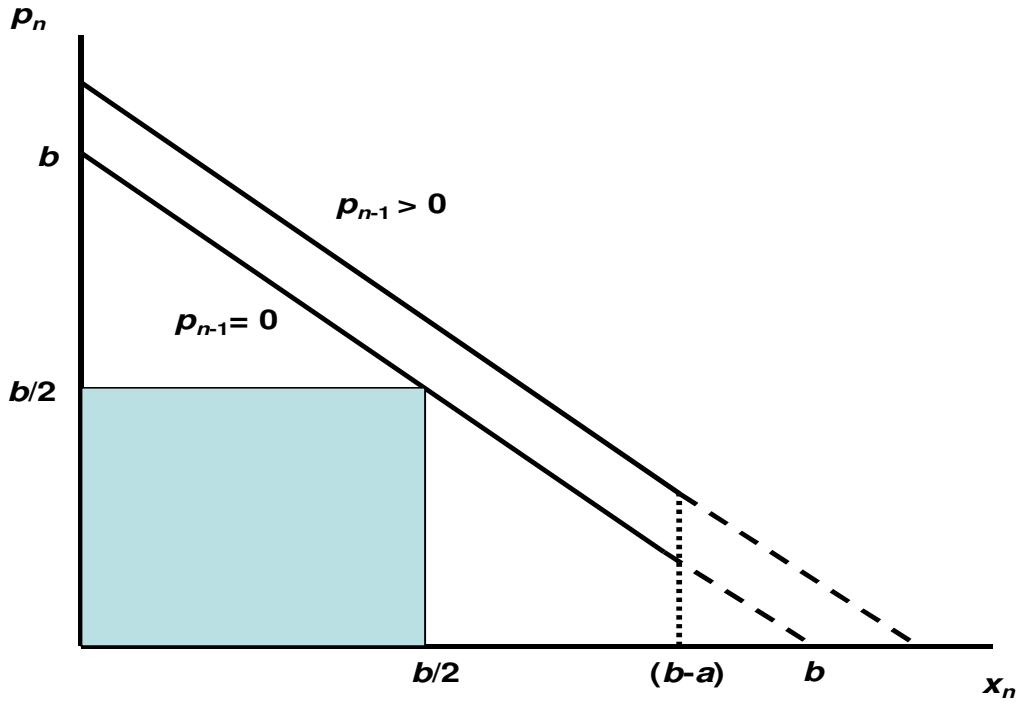


Figure 2: Demand for vertically differentiated good

Firms' profits are:

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

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

Bertrand-Nash equilibrium prices being:

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

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

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

- *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):

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

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

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 (Figure 3)**

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

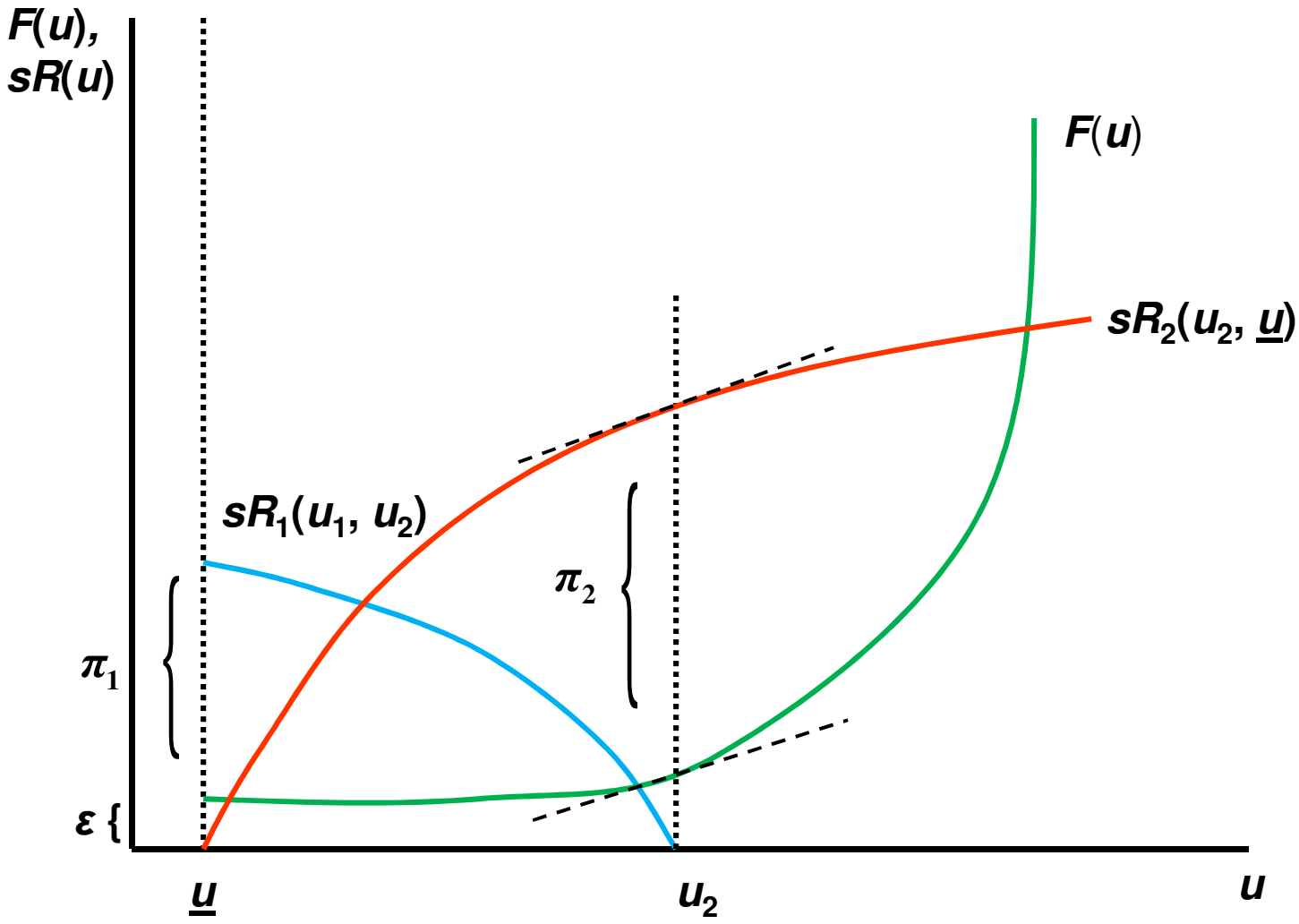
- ***As u_2 increases,* (i) *welfare of consumers purchasing low-quality good decreases,* (ii) *proportion of consumers purchasing low-quality good declines, and* (iii) *aggregate consumer welfare increases***

(i) See utility function (1)

(ii) Differentiate (3) w.r.t u_2, $\dfrac{\partial y'}{\partial u_2} = -\dfrac{2u_1u_2(2b-a)}{3(u_2-u_1)^3} < 0$

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

Figure 3: 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., $s^i = s_1 + s_2$ (see Figure 4)**

  - **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 (see Figure 5)**

- ***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 4: North-North Income Distribution

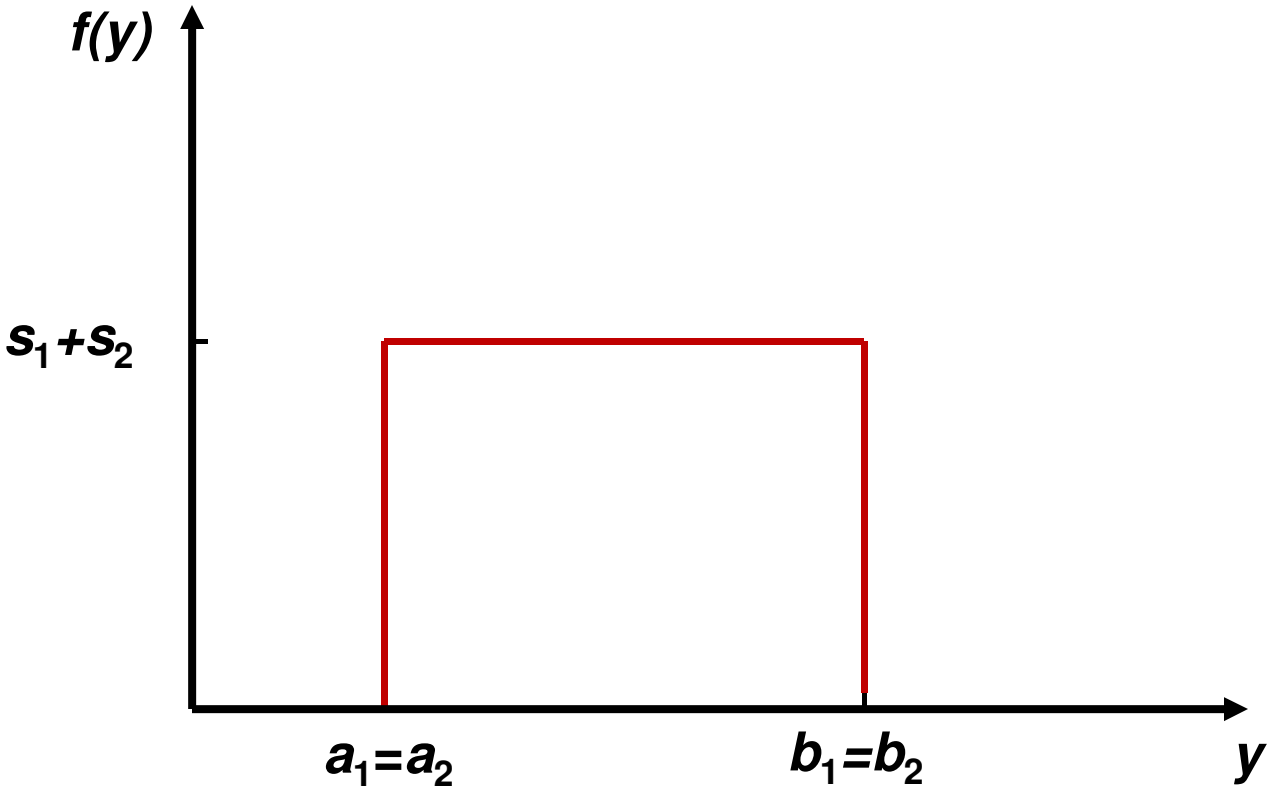


Figure 5: North-North trade equilibrium – *PI* case

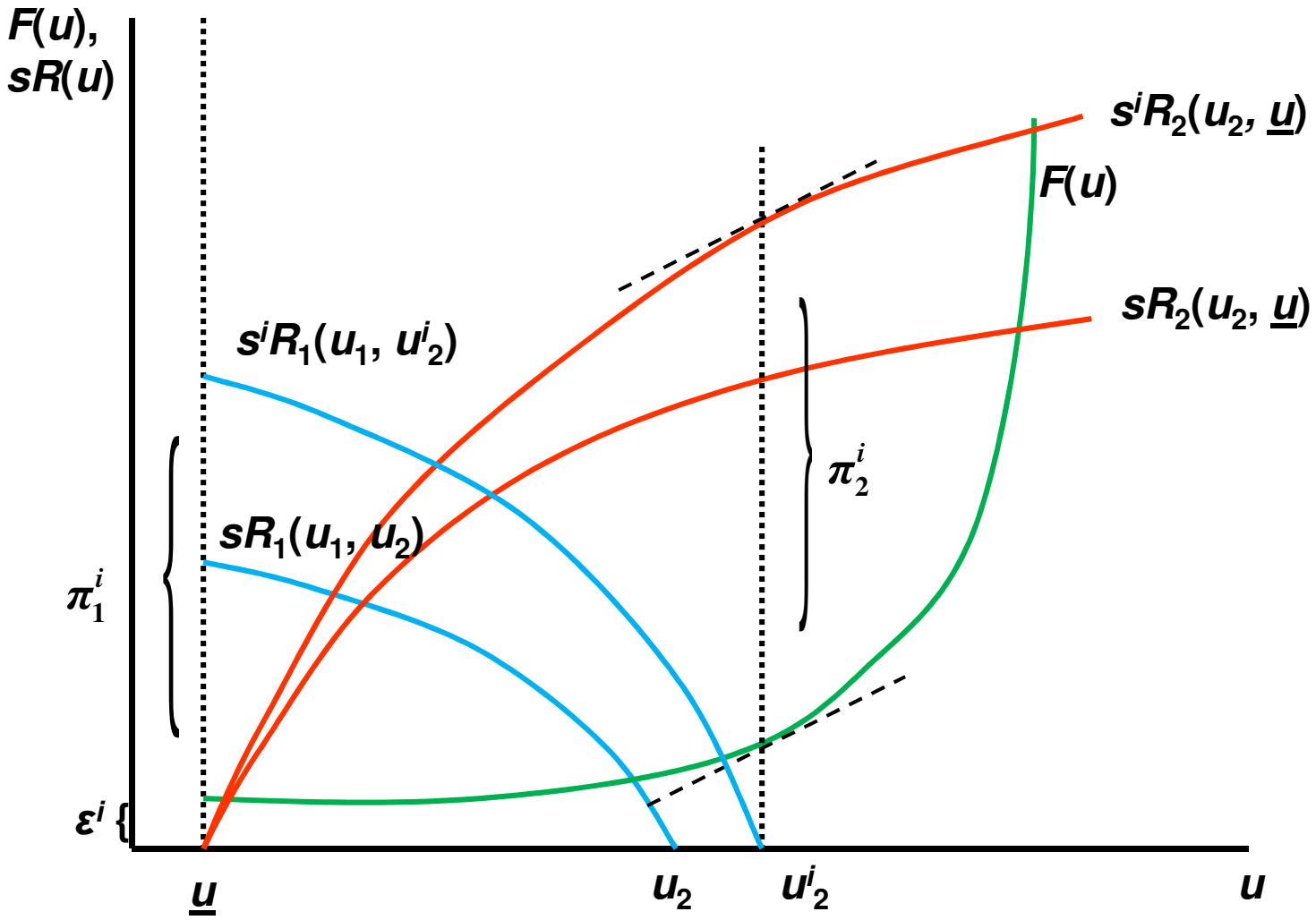


Table 1: Labeling regimes – North/North trade

	MEC	*MNC*	*MED*	*MND*
Harmonized	**Replicates *PI***	**Replicates *PI***	**May be *XL* (see Figure 6)**	**Replicates *PI***
Mutual recognition	**Replicates *PI***	**Replicates *PI***	**May replicate *PI***	**Replicates *PI***

***PI* – perfect information**

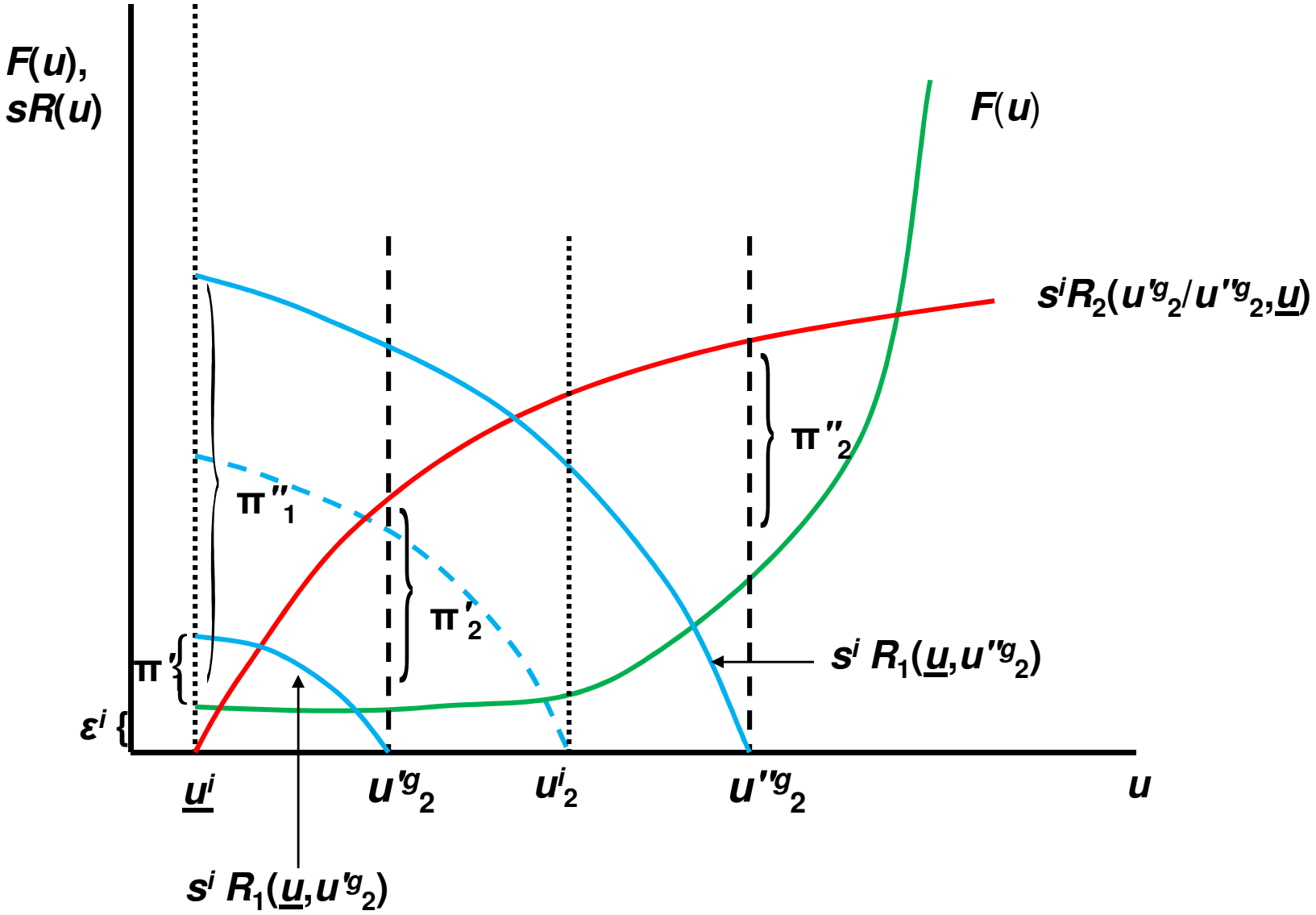
***XL* – no labeling**

***MEC* – mandatory, exclusive, continuous**

***MNC* – mandatory, non-exclusive, continuous**

***MED* – mandatory, exclusive, discrete**

Figure 6: North-North Trade – harmonized *MED* case



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, $a_N/2 < a_S < a_N < b_N/2 < b_S < b_N$ (see Figure 7)**

  - **gains from trade occur due to lower prices in equilibrium**

  - ***XL* generates monopoly outcome**

  - **harmonized/mutual recognition *MEC/MNC* replicates *PI***

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

  - **harmonized/mutual recognition *MND* replicates *PI***

Figure 7: North-South Income Distribution