Credence Good Labeling and Trade

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Motivation

- Goods increasingly differentiated by process attributes, e.g., organic food, GMOs, sustainable forest management, low emissions electricity
- Consumers unable to verify claims about attributes, i.e., form of *credence good* (Darby and Karni, 1973)
- Labeling possible, but issues of implementation:
  - 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

Background

- Sheldon and Roe (2009a), allow for integration of two economies where they either agree to harmonize or mutually recognize labeling regulations
- Look at two cases of economic integration:
  - Identical income distributions → North-North
  - Overlapping income distributions → North-South
- For North-North and North-South integration, exclusive and continuous labeling delivers same prices and qualities as under perfect information
- With mandatory, exclusive, and discrete labeling, welfare effects depend on whether countries harmonize or mutually recognize their labeling rules

Model

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

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

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

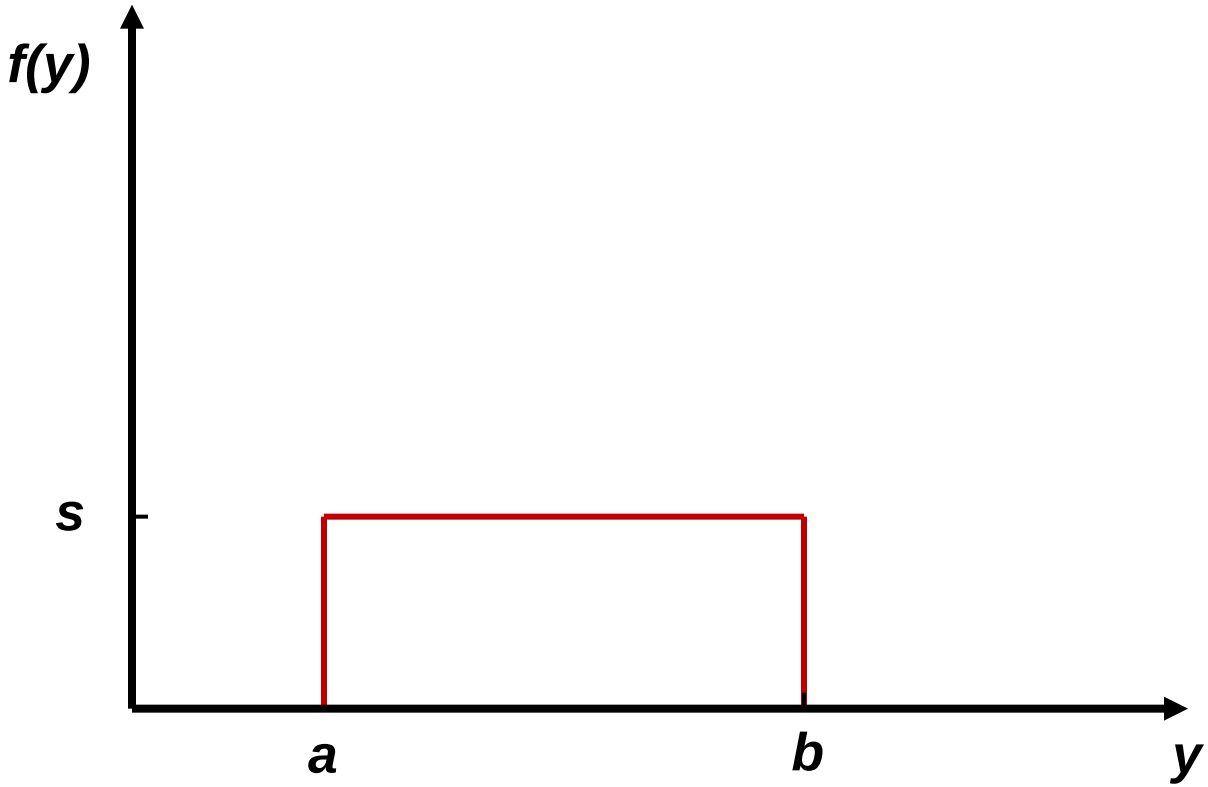
where $u \in [\underline{u}, \infty]$ **is quality level of differentiated good and** $\underline{u} > 0$ **is minimum quality-standard, and (*y*-*p*) is expenditure on Hicksian composite good**

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 can 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) $4a > b > 2a$ **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:**

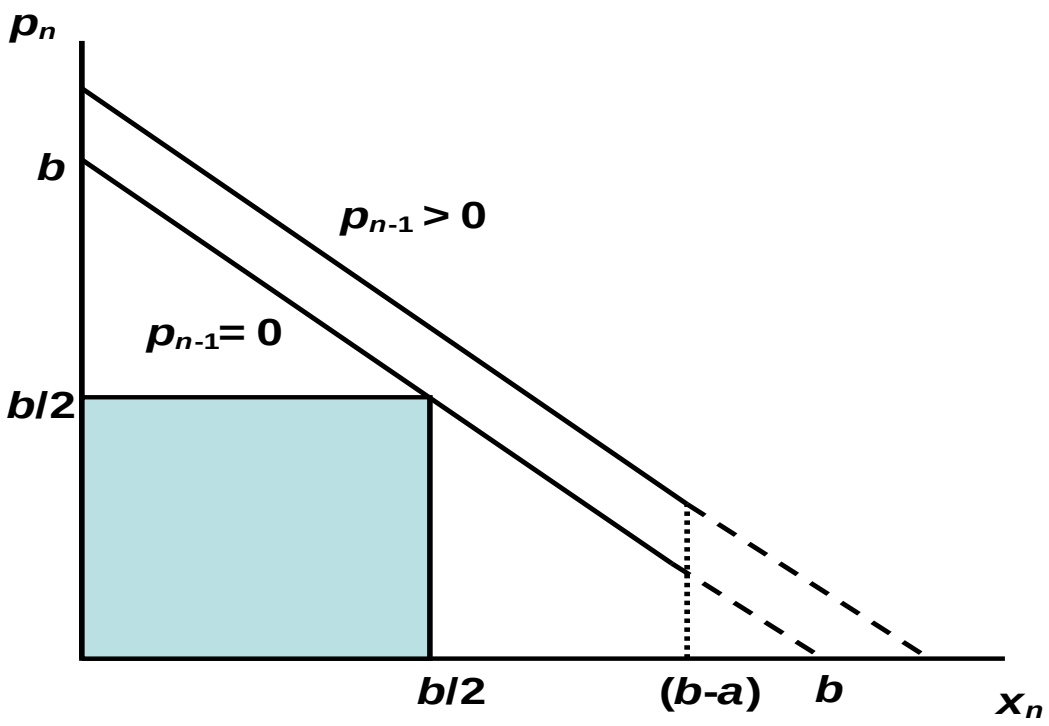
(3) $y' = (1 - r)p_1 + rp_2$,

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**

Demand for Vertically Differentiated Product

- In Figure 2, firm offering good of quality u_n competes with quality u_{n-1} offered at $p_{n-1}=0$
- Vertical intercept of linear demand for n is determined by b, and as p_n falls, more consumers willing to purchase it compared to n-1 at a zero price
- If p_n falls enough, even consumers at lower end of distribution a are willing to purchase n, i.e., total demand being (b-a), n covering market
- Firm offering n maximizes profits at price where market share is $b/2$, so that if (b-a)<$b/2$, captures whole market, and if (b-a)>$b/2$, n no longer covers market, with two goods having positive market share if $b<4a$

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

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

(6) and (7) holding if $p_1 \leq a$, so that $u_1 \geq \hat{u}_1(u_2) = \dfrac{u_2(b - 2a)}{b + a}$ and $u_2 \leq \hat{u}_2(u_1) = \dfrac{u_1(b + a)}{b - 2a}$, equivalent to $u_2 / u_1 \geq (b + a) / (b - 2a)$

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

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

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

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

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

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

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

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

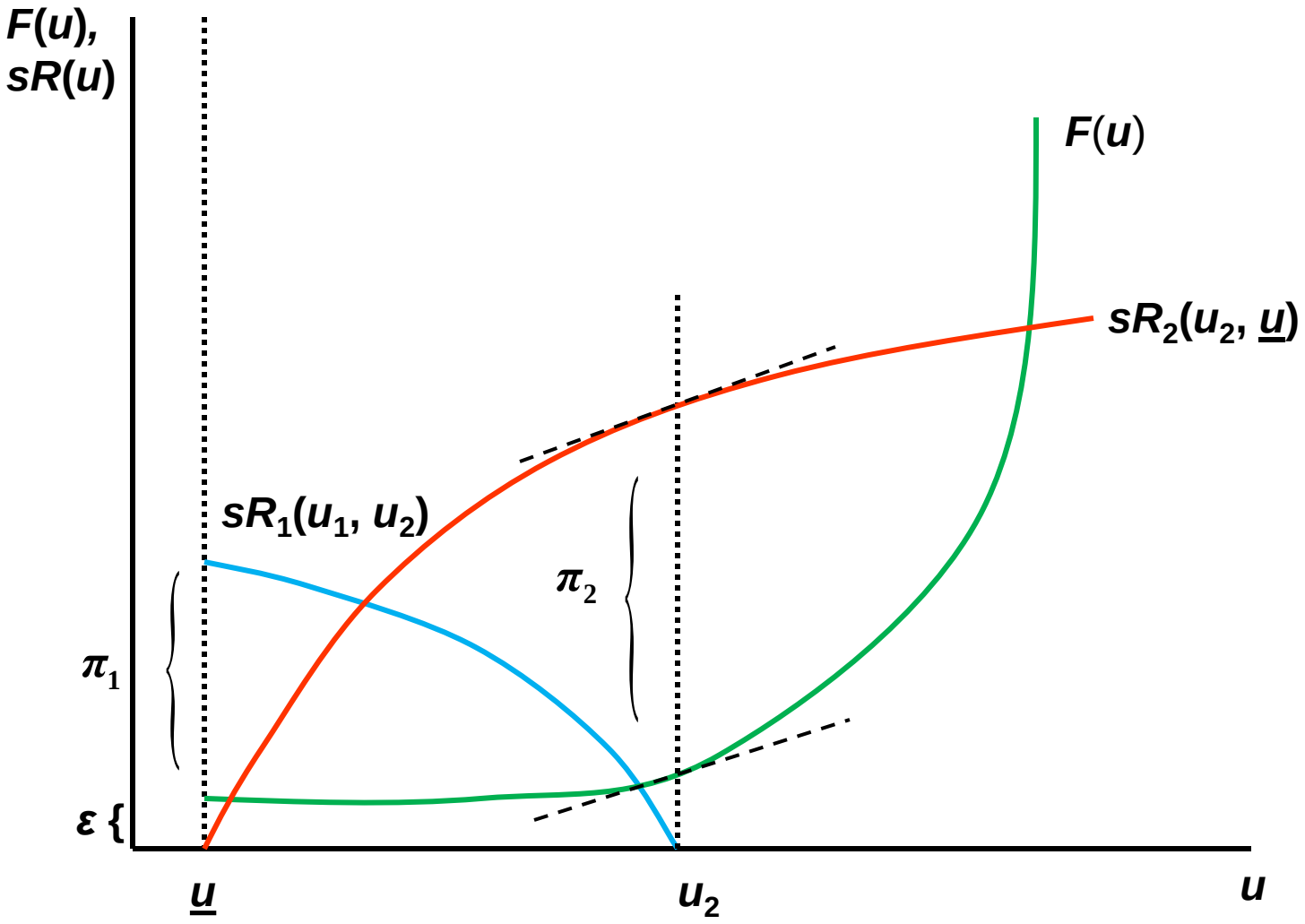
- ***As u_2 increases,* (i) *welfare of consumers purchasing low-quality good decreases,* (ii) *proportion of consumers purchasing low-quality good declines, and* (iii) *aggregate consumer welfare increases***

(i) See utility function (1)

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

(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, (see Figure 2) – cannot predict location of remaining 2 firms

- increase in quality of good 2, quality of good 1 remaining the same (see Figure 5)

Figure 4: North-North Income Distribution

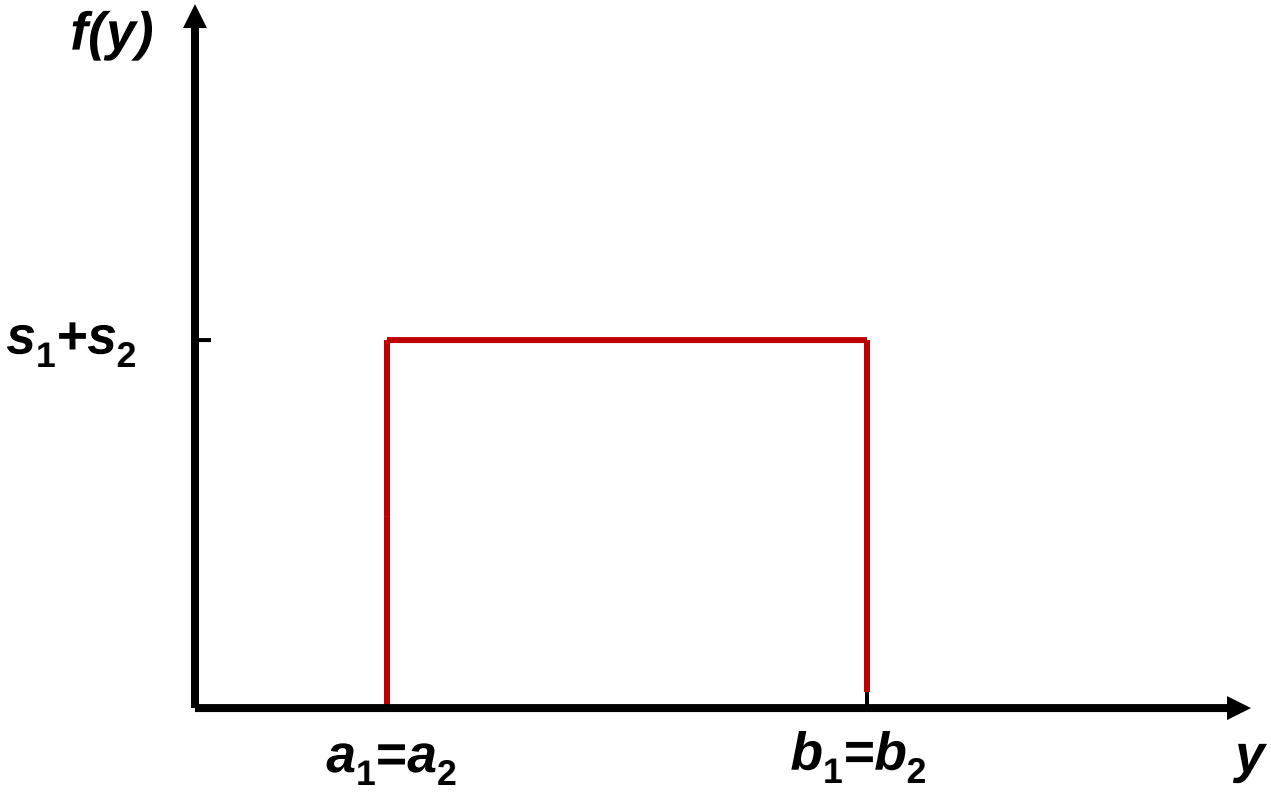
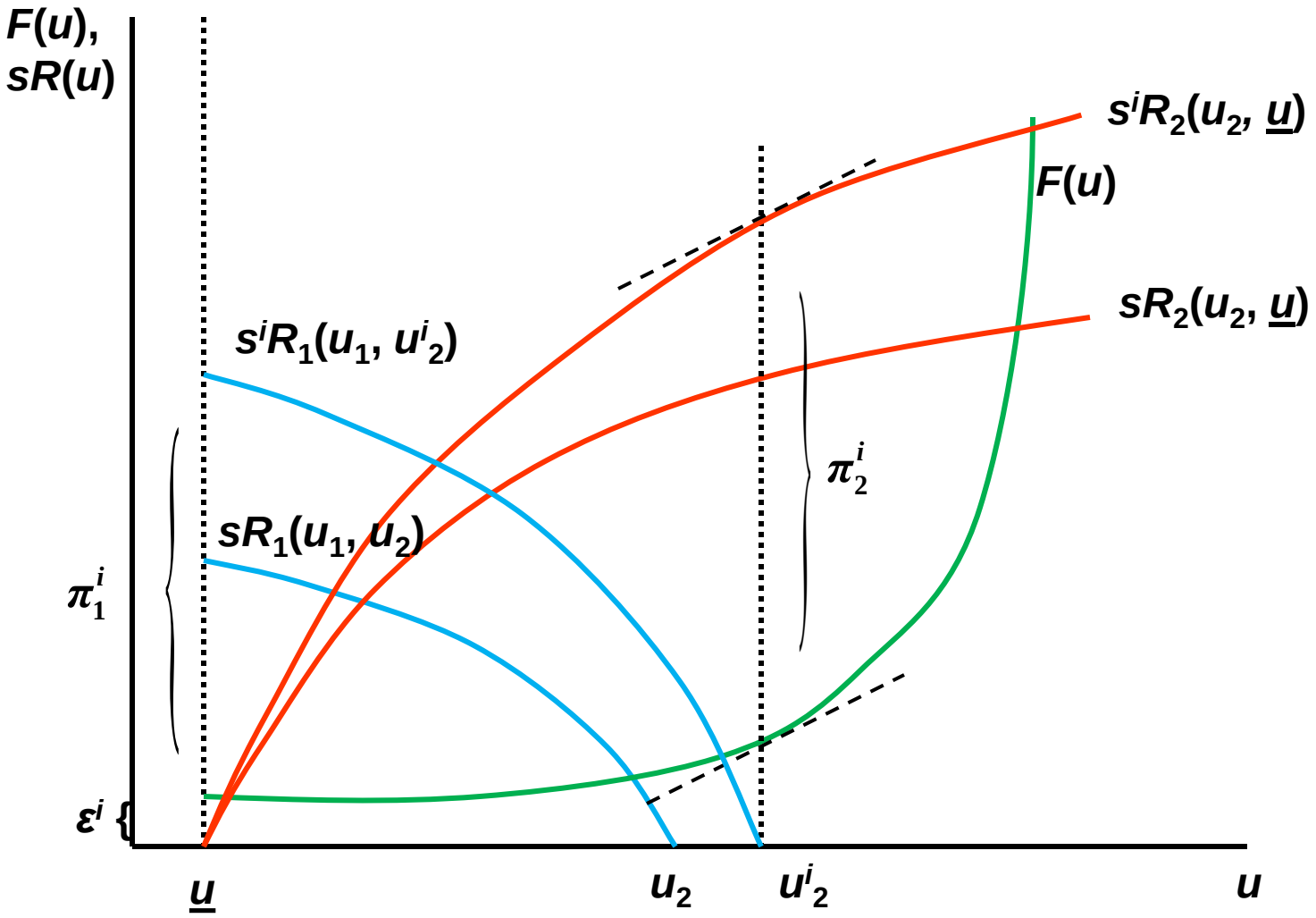


Figure 5: North-North trade equilibrium – *PI* case



North-North Integrated Equilibrium

- ***Trade with no labeling (XL)***

  - **sunk cost of entry, ε^i, combined with 3-stage game supports entry of single firm into integrated market, lack of labeling leading to production of lowest quality, $\underline{u}$**

  - **price is monopoly outcome given linear demand structure that emerges from a uniform distribution of income**

  - **only circumstance under which multiple firms enter selling low-quality good is case of a perfectly *contestable* market where $\varepsilon^i = 0$**

  - **due to $p^{XL} = b/2$, and by restriction on income distribution, $a < b/2$, poorer consumers will not consume under monopoly**

North-North Integrated Equilibrium

- ***Trade with mandatory, exclusive, continuous labeling* (*MEC*)**

  - firms can perfectly communicate quality level, only difference to PI case is high-quality firms incur labeling costs

- ***Trade with mandatory, exclusive, discrete labeling* (*MED*)**

  - under *harmonized* standards, risk that one firm is driven from market (see Figure 6)

  - with *mutual recognition* of standards, higher probability gains from economic integration will be realized

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

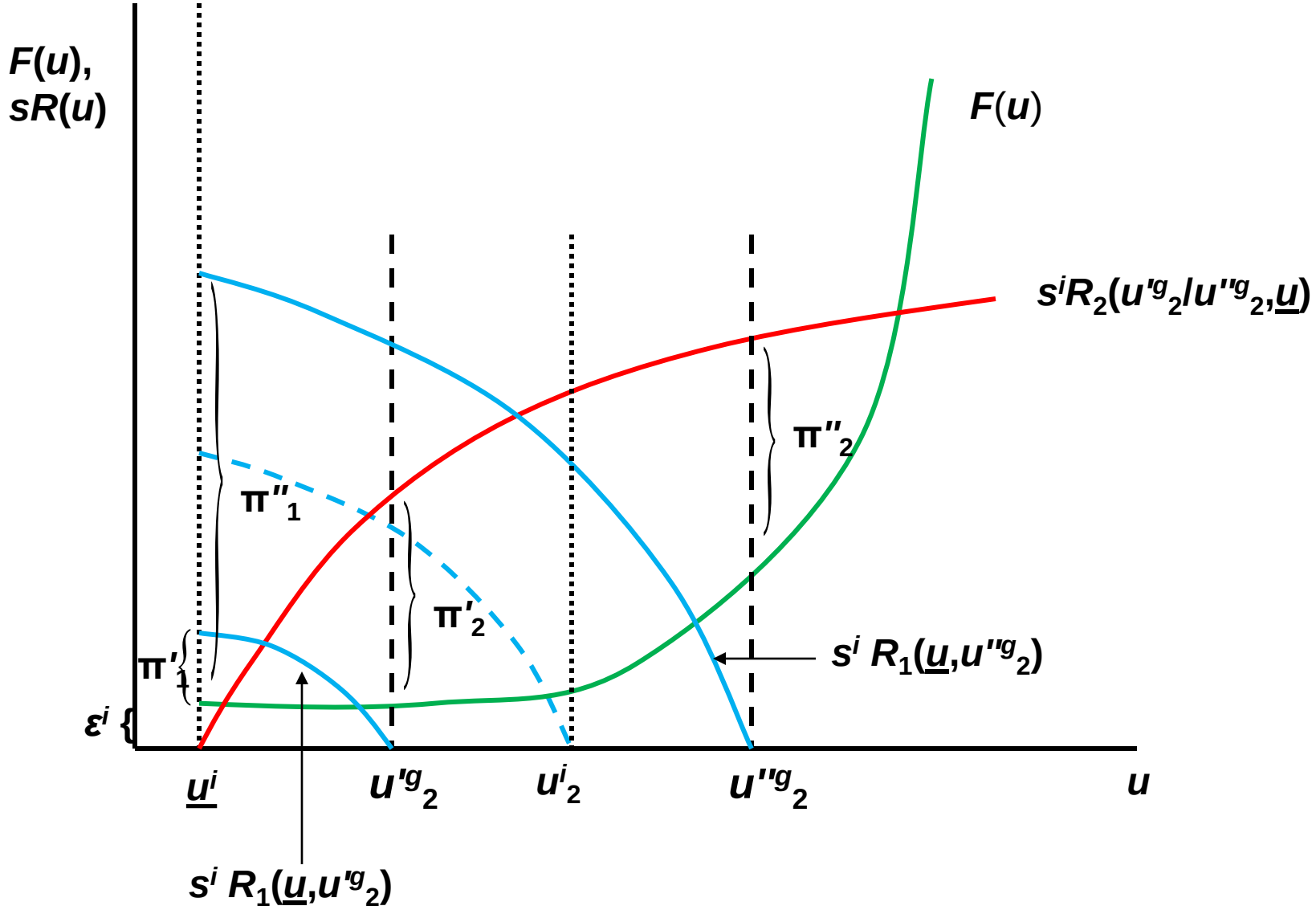


Table 1: Labeling regimes – North/North trade

	MEC	*MED*
Harmonized	**Replicates *PI***	**May be *XL***
Mutual recognition	**Replicates *PI***	**May replicate *PI***

***PI* – perfect information**

***XL* – no labeling**

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

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

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

Figure 7: North-South Income Distribution

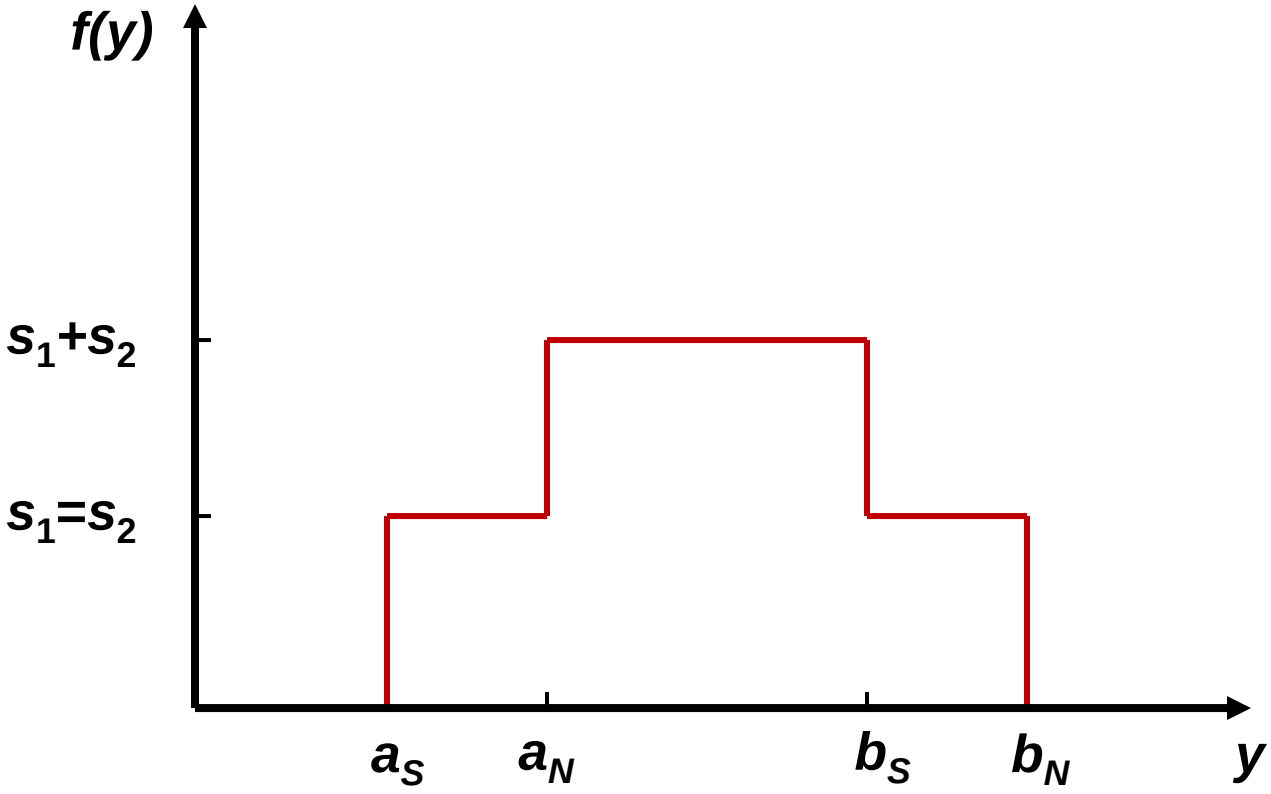


Table 2: Labeling regimes – North/South trade

	MEC	*MED*
Harmonized	**Replicates *PI***	**May be *XL***
Mutual recognition	**Replicates *PI***	**May replicate *PI***

***PI* – perfect information**

***XL* – no labeling**

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

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

Conclusions

- **Results have important conclusions for labeling programs when economies integrate in presence of credence goods**
- **Additional firms may enter in both North-North and North-South case if labeling is present and labeling costs are not too high; consumers have greater choice and competition drives down prices**
- ***MEC* delivers same equilibrium as perfect information case, but harmonized *MED* may cause quality distortion, although this is less likely in case of *MED* with mutual recognition of standards**
- **If private certification is allowed, it can lower risk that high-quality goods are pushed out of market if standard(s) are set too low (Sheldon and Roe, 2009b)**