“Sustainable Agricultural Production, Income and Eco-Labelling: What Can Be Learned from a Neo-Ricardian Approach?”

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General Remarks

- Definition of sustainability matters, i.e., weak vs. strong

- Economic models accounting for sustainability objectives highlight importance of interdisciplinary research – especially *ex post* evaluation

- Nature and resolution of information asymmetries over sustainability is critical, i.e., *diagnosis* vs. *treatment*

- Need to account for income effects in analyzing standards

- Trade models need to do better job of accounting for vertical market structures

- With free-riding in sustainability agreements, economic/legal analysis of standards may have to address issue of appropriate border adjustments
Motivation

- Analysis of agricultural system should recognize extent of vertical product differentiation, e.g., environmental and sustainable production claims (Sexton, 2013)

- Eco-labelling key to resolving information asymmetry associated with environmental *credence* products

- Rapid growth of eco-labelling relating to food and agricultural products since 1970s (Gruére, 2013)

- Trade often expected to generate negative externalities (Copeland and Taylor, 2004)

- However, if production generates sustainability benefits, eco-labelling beneficial (Swinnen, 2015)
Outline

- Develop Ricardian-type model drawing on Eaton and Kortum (2002), and others including, *inter alia*, Fieler (2011), and Levchenko and Zhang (2014)


- Use to derive comparative statics concerning impact of eco-labelling of and trade in sustainable products, allowing for non-homothetic preferences

- Sustainability dimension relates to use of water
Water

- Competition for scarce water resources has intensified in past 70 years (Molden, 2007)

- Although perceived by many as an abundant natural resource, fresh water is becoming limited due to over-consumption – posing threat to humans, ecosystems, and biodiversity (Weinzettel and Pfister, 2019)

- 80% of world’s population live in areas where there is significant risk to water security – notably regions of intensive agriculture (Vörösmarty et al., 2010)

- Steffen et al. (2015) propose boundaries on annual global water consumption
Modern Ricardian Approach

- Dornbusch, Fischer and Samuelson (1977) two-country model gives some intuition (Figures 1)
- Difficult to adapt to multi-country setting
- Contribution of Eaton and Kortum (2002): focus on parameters of productivity distribution
- Given country will be more productive than others at producing range of products in continuum – generates reason for trade with implications for sustainability
- Following Heerman (2020), local agroecological characteristics also included in analysis
Figure 1: Comparative Advantage in the Continuum
Model

- There are $I$ countries that trade products $j^k$, produced along a continuum, with technology $k \in U,S$:

  \[ q_i^U(j^U) = z_i(j^U) \left( a_i(j^U) \Upsilon_i \right) \]

  \[ q_i^S(j) = z_i(j^S) \left( a_i(j^S) \Upsilon_i \right)^\alpha H_i^{1-\alpha} \]

- $z_i(j^k)$ is distributed independently as Fréchet:

  \[ F_i^k(z) = \exp\left\{-T_i z^{-\theta^k}\right\} \]

- Prices offered by exporter $i$ in $n$:

  \[ p_{ni}^U(j^U) = \frac{\tilde{a}_i(j^U) c_i^U(j^U) \tau_{ni}}{z_i(j^U)} \]

  \[ p_{ni}^S(j^S) = \frac{\tilde{a}_i(j^S) c_i^S(j^S) \tau_{ni} \zeta_{ni}}{z_i(j^S)} \]
Model

- Consumers have preferences over products, choosing $S$ and $U$ to maximize:

\[
\frac{\sigma^U}{\sigma^U - 1} \left( \int_0^1 q_i^U (j^U) \frac{\sigma^U - 1}{\sigma^U} dj^U \right) + \frac{\sigma^S}{\sigma^S - 1} \left( \omega_i^{\sigma^S} \int_0^1 q_i^S (j^S) \frac{\sigma^S - 1}{\sigma^S} dj^S \right)
\]

- Implies total expenditure on $S$ relative to $U$:

\[
\frac{X_i^S}{X_i^U} = \lambda_i^{\sigma^U - \sigma^S} \left( \frac{\omega_i P_i^{S^1 - \sigma^S}}{P_i^{U^1 - \sigma^U}} \right)
\]

$P_i^k$ is CES price index – consumers choose $S$ if labelled, i.e., no asymmetric information about either diagnosis or treatment.
Model

- Consumers in $n$ buy $U$ and $S$ at lowest price on offer:
  \[ p_n^k(j^k) = \min_i \{ p_{ni}^k(j^k) \}, \quad k = U, S \]

- Using price distributions, probability $i$ offers lowest prices of $S$ and $U$ products in $n$:
  \[
  \pi_{ni}^S = \frac{T_i(\tilde{a}_i(j^S)c_i^S(j^S)\tau_{ni}\zeta_{ni})^{-\theta^S}}{\Phi_n^S(j^S)}
  \]
  \[
  \pi_{ni}^U = \frac{T_i(\tilde{a}_i(j^U)c_i^U(j^U)\tau_{ni})^{-\theta^U}}{\Phi_n^U(j^U)}
  \]

- With continuum, these are also fraction of products that consumers in $n$ purchase from $i$
Comparative Statics: Labelling

Labelling increases $S$ trade flows:

(i) Labelling increases share of $S$ expenditure on imports:

$$\pi_{nn}^S = \frac{T_n \left( \tilde{\alpha}_n(j^S)c_n(j^S) \right)^{-\theta^s}}{\sum_{l=1}^{I} T_l \left( \tilde{\alpha}_l(j^S)c_l(j^S)\tau_{nl}\zeta_{nl} \right)^{-\theta^s}} = \frac{T_n \left( \tilde{\alpha}_n(j^S)c_n(j^S) \right)^{-\theta^s}}{\Phi_n^S(j^S)}$$

Without labelling $\zeta_{ni} = \infty$, therefore:

$$\Phi_n^S(j^S) = T_n \left( \tilde{\alpha}_n(j^S)c_n(j^S) \right)^{-\theta^s} \text{ and } \pi_{nn}^S = 1$$

As labelling costs fall, $\Phi_n^S(j^S)$ increases and $\pi_{nn}^S$ falls, i.e., import share of expenditure on $S$ products rises.
Comparative Statics: Labelling

(ii) Labelling increases share of total expenditure allocated to S products:

By definition, \( X_i = X_i^S + X_i^U \), therefore:

\[
\frac{X_i^S}{X_i} = \lambda_i^{\sigma^U - \sigma^S} \left( \frac{\omega_i \left( \frac{P_i^S}{P_i^U} \right)^{1-\sigma^U}}{1 + \omega_i \left( \frac{P_i^S}{P_i^U} \right)^{1-\sigma^S}} \right)
\]

Therefore, lower labelling costs implies lower prices for S products

Since lower labelling costs have no impact on \( \Phi_n^U(j^U) \), introducing S labels lowers \( \left( \frac{P_i^S}{P_i^U} \right) \)
Comparative Statics: Composite Input and $S$

- Optimal composite input allocation implies:

$$
\frac{\gamma_i^S}{\gamma_i^U} = \frac{\sum_n \pi_{ni}^S X_n^S}{\sum_n \pi_{ni}^U (X_n - X_n^S)}
$$

Established that $\pi_{ni}^S$ increases with eco–labelling, as does share of expenditure allocated to $S$

$X_n - X_n^S$ is also decreasing in import markets where labeling of $i$’s $S$ products is introduced

Therefore, share of composite input allocated to $S$ production increases for exporter $i$ – generating sustainability gains
Comparative Statics: Income and Trade

- If $\sigma^S > \sigma^U$, relative expenditure on $S$ increasing in income - so for high-income country, $X_{ni} / X_{nn} \approx X^S_{ni} / X^S_{nn}$, and:

  $$\frac{X^S_{ni}}{X^S_{nn}} = \frac{T_i}{T_n} \left( \frac{\tilde{a}_i(j^S)c_i(j^S)\tau_{ni}\zeta_{ni}}{\tilde{a}_n(j^S)c_n(j^S)\tau_{nn}\zeta_{nn}} \right)^{-\theta^S}$$

- Impact of eco-labelling cost becomes less critical as $\theta^S$ falls - average agricultural productivity drives imports from $i$

- Trade not necessarily dominated by high-income countries, i.e., if $\tilde{a}_i(j^S)c_i(j^S)$ are low, and value of $\theta^S$ is not too low, low-income country able to export $S$

- Assumes producers in low-income countries have access to $H$, and ability to certify credence products
Next Steps

- Parameterize model to evaluate impact of eco-labelling policies – not straightforward gravity-type approach

- Need tractable method of capturing non-homothetic preferences, i.e., allowing for substitution to sustainable products as per capita income increases

- Build empirical connection between agricultural production, agroecological characteristics and use of water resources

- Incorporate vertical market structure and figure out how rents from standards get shared out