THE POTENTIAL ROLE OF INTERNATIONAL BARCODE OF LIFE (IBOL) TECHNOLOGY IN GOVERNANCE AND INTERNATIONAL REGULATORY PROTOCOLS

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Introduction

The increasing publicized cases of food fraud and cross border trade of unidentified and invasive plant and animal species across the world have prompted government and industry-led investments in developing traceability and authenticity-enhancing technologies. Globalization and trade liberalization have led to increased volume of agricultural products traded across national boundaries. This has posed serious challenge of ensuring the authenticity of traded commodities as the economic gains accruing to sellers of genuine products have given some producers and other members of the agri-food chain an economic incentive to cheat consumers by misrepresenting their own products and substituting substandard products for legitimate items. This gives rise to information asymmetry problem (market for lemons), and consequently adverse selection. To ensure consumers' safety, government of different countries have developed different food safety standards, authenticity testing procedures and border control measures, which have resulted in trade conflicts, border rejections and reduced market access. Existing quality verification and authentication methods (e.g. morphological features, electrophoresis, Polymerase Chain Reaction, etc) have not recorded significant success, especially in the area of specie identification due to some limitations. Emerging authenticity technologies have the potential to verify quality claims and enhance market access. The paper specifically focuses on fish products.

Challenges

1. **Consumers incur transaction (search) costs in search for credence attributes during time of purchase. E.g.**

❖ This leads to adverse selection and consequently, consumers will pay premium for low valued and/or low quality fish.

2. **Existing systems of identification involve the use of:**

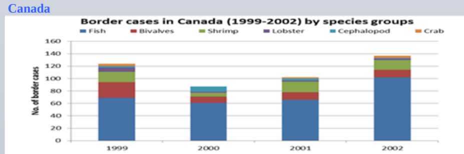
❖ morphological features, which may be absent in processed products such as fish fillets (Wong and Hanner, 2008)

❖ Electrophoresis, which is protein-based and cannot be used on cooked/processed products as protein often denatures at temperatures above 80°C (Petterson and Jones, 1990)

❖ PCR method, which is specie-specific may not be used to identify a wide range of species found in the market today

3. **Trade conflicts and border rejections due to authenticity issues**

Canada



Source: Data from CFIA in Ababouch, Gandini and Ryder (2005, p.49)

❖ out of 450 border cases involving seafood products between 1999 and 2002, 298 (66.2%) cases involved fish

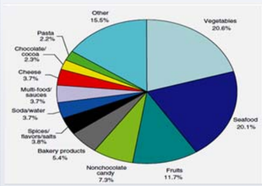
European Union

Source: Data from RASFF annual report (2011, p.38)

❖ Shows a steady increase in number of border rejections in the last six years due to adulteration/fraud, presence of foreign bodies, parasitic infestation, pesticide residues, poor or insufficient controls, etc.

Challenges Cont'd

Unites States



❖ 70,369 food import violation cases were recorded between 1998 and 2004. 33% were as a result of mislabelling and 65% were for adulteration

❖ 20.1% violations were on seafood and 22.28% of total refusals involve seafood

FDA import violations by industry (1998 – 2004)

Source: ERS calculations using FDA Food-Related Import Refusal Reports, 1998-2004 in Buzby, Unnevehr and Roberts (2008)

Objectives

The paper examines:

❖ an emerging authenticity technology, the International Barcode of Life (IBOL), used to identify plants and animal species through DNA sequencing;

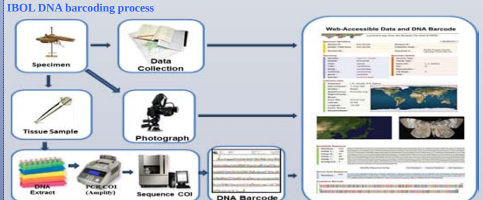
❖ the potential of embedding IBOL technology into the framework of the international regulatory system;

❖ its potential adoption in Canada for seafood (fish) species identification, and its trade effects in Canada and rest of the world.

IBOL Technology

❖ Identifies species using DNA sequencing

IBOL DNA barcoding process



Sources: Floyd et al. (2010), Yancy (2007)

IBOL and International Regulatory System

WTO trade Agreement (SPS measures) gives Member countries sovereign right to establish their own standards and methods of inspecting products, which must be based on scientific risk assessment, and seek higher standards if the international standards are inadequate to achieve their desired level of sanitary or phytosanitary protection so long there is scientific justification (Article 3.3). Therefore, these methods should not impede international trade.

However,

❖ Absence of acceptable scientific consensus and strong preferences have made these standards a potential tool for trade restriction and protectionism, and scientific justification a contentious issue

→ a motivation for government and industry-led traceability systems

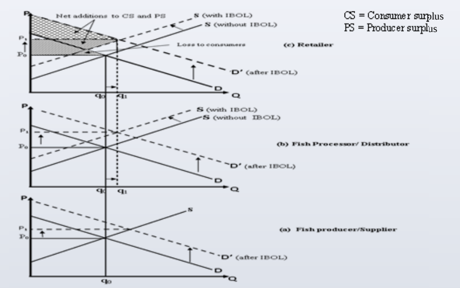
❖ IBOL is completely science based, permits repeatability with high precision, and has common procedure, which is in line with SPS Agreement; standards, procedures and recommendations set by relevant international bodies, such as, Codex and OIE

❖ uses of reference library with common names of species for easy identification. This justifies international standardization, and will potentially increase the credibility of the system, reduce transaction costs and disguised trade barriers

Theoretical Models

IBOL technology adoption in Canada

a) autarky case



The fish supply chain

❖ In practice, the private sector would adopt IBOL if the private market benefits (e.g. increase in demand and profit) are greater than the market opportunity costs (i.e., perceived benefits exceed the costs). It is assumed here that the size of demand shift is greater than the shift in MC

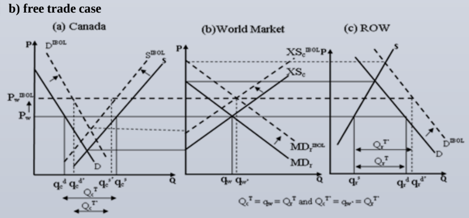
❖ Adoption of IBOL technology potentially will take place at the processor and retailer stages along the supply chain in order to gain consumer trust and protect their reputation; hence, an increase in MC, which shifts the supply curve to the left

❖ At the supplier stage, there is no adoption cost, but the size of the demand shift depends on the outcome of the authenticity test carried out by the processor or distributor

❖ The price charged at each stage is contingent on the relative market power exhibited by each participant at each level of the supply chain

❖ Relative sizes of changes in CS and PS depend on the relative shifts in demand and supply curves, and on elasticities. Therefore, it is more of a computable problem than theoretically derived results

b) free trade case



XS = Excess supply; MD = Import demand; ROW = Rest of the World

Trade and welfare effects of IBOL technology adoption under free trade

❖ Prior to IBOL, at price $\mathbf{P_w}$, $\mathbf{q_c^s}$ and $\mathbf{q_c^d}$ quantities are supplied and demanded in Canada respectively while $\mathbf{q_w}$ quantity is supplied at the world market and demanded by ROW

❖ Adoption of IBOL increases marginal costs for Canadian exporters and consumer price (decrease in Consumer surplus), hence a reduction in quantity of fish demanded and supplied in Canada in the short run. However, the authenticity and quality assurance of Canadian fish trigger increased import demand by the ROW. Demand in Canada would presumably increase with time and consumer awareness of the authenticity technology

❖ Canadian fish exporters are better off with increased domestic and international demand and price of their fish products, which would compensate for the increase in marginal costs resulting from technology adoption

❖ Again. the relative sizes of the changes in consumer and producer surpluses, and magnitude of price change depend on the relative shifts in the demand and supply , and on elasticities

Empirical Model

IBOL technology induced change in price

❖ Here, an empirical model is used to show the relative change (increase) in price of fish resulting from the use of IBOL technology in fish species identification and authentication, which is an economic incentive to adopt the technology by the private sector

Equilibrium price before technology adoption

Canada supply: $Q_c^s = \alpha_c + \beta_c P_w$ (1)

Canada demand: $Q_c^d = \mu_c - \gamma_c P_w$ (2)

ROW supply: $Q_r^s = \alpha_r + \beta_r P_w$ (3)

ROW demand: $Q_r^d = \mu_r - \gamma_r P_w$ (4)

$Q_c^s + Q_r^s = Q_c^d + Q_r^d$ - trade equilibrium condition

$$P_w^* = \frac{(\mu_c+\mu_r-\alpha_c-\alpha_r)}{(\gamma_c+\gamma_r+\beta_c+\beta_r)} \quad (5)$$

Equilibrium price after technology adoption

Canada supply: $Q_c^s = \alpha_c + \beta_c P_{w'}$ (6)

Canada demand: $Q_c^d = \mu_c - \gamma_c (P_{w'}+k)$ (7)

ROW supply: $Q_r^s = \alpha_r + \beta_r P_{w'}$ (8)

ROW demand: $Q_r^d = \mu_r - \gamma_r P_{w'}$ (9)

$Q_c^s + Q_r^s = Q_c^d + Q_r^d$ - trade equilibrium condition

$$P_{w'}^* = \frac{(\mu_c+\mu_r-\alpha_c-\alpha_r-\gamma_c k)}{(\gamma_c+\gamma_r+\beta_c+\beta_r)} \quad (10)$$

Where k = KP_w = % increase in demand and price of fish with IBOL

$$\Rightarrow P_{w'}^* = \frac{(\mu_c+\mu_r-\alpha_c-\alpha_r-\gamma_c KP_w)}{(\gamma_c+\gamma_r+\beta_c+\beta_r)} \quad (11)$$

$$\text{IBOL induced change in price of fish} = P_{w'}^* - P_w^* = -\frac{\gamma_c KP_w}{\gamma_c+\gamma_r+\beta_c+\beta_r} \quad (12)$$

$$\text{Relative change in price (Z)} = -\frac{(P_{w'}-P_w)}{P_w} = -\frac{\gamma_c K}{\gamma_c+\gamma_r+\beta_c+\beta_r} \quad (13)$$

$$|Z| = \frac{\gamma_c K}{\gamma_c+\gamma_r+\beta_c+\beta_r} \quad (14)$$

❖ The magnitude of IBOL induced price change depends of the elasticities of demand and supply

Conclusions

❖ Application of IBOL technology in fish and seafood identification and authentication will potentially reduce fraud (substitution and mislabeling) in fish markets, increase market access and strategically position Canadian fish exporters in international markets to gain first-mover advantage

❖ IBOL technology uses science-based technique in verifying quality claims, and therefore, has a potential of being embedded in the international regulatory systems for authenticity and food safety; having satisfied the required standards and procedures laid down in WTO Agreements (e.g. SPS and TBT) and international regulatory institutions (e.g. Codex)

❖ Adoption of the technology in Canada would presumably instill discipline and enhance quality control in fish supply chain; although the positive effect from the private sector perspective (e.g. increased domestic demand for fish) may not occur in the short run, but would potentially be experienced in the long run

❖ The next steps in the analysis would be the empirical determination of cost effectiveness of IBOL technology in Canada relative to the existing systems, and the relative sizes of changes and distribution of consumer and producer surpluses resulting from technology adoption

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