EXPLORING THE ADOPTION OF AUTHENTICITY TECHNOLOGIES IN CANADIAN AGRI-FOOD SECTOR

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Introduction

Highly publicized cases of food fraud in recent years have prompted consumers to become interested in the authenticity, traceability and origin of their food. This has spurred public and private sector investments in quality assurance, traceability and authenticity-enhancing technologies. Globalization has meant Increased cross border trade of agricultural food products, including unidentified and invasive animal and plant species thereby creating a complex agri-food supply chain where traceability, quality and authenticity have become a serious challenge. In a bid to compete for economic gains, some producers and intermediaries along the food supply chain may engage in illegitimate market activities, including unlabelled substitution of substandard products, mislabelling and misrepresentation of products. These create 'market for lemons' problems, negative reputation externalities for other agri-food firms, transaction (search) costs for consumers, international trade conflicts and border rejections.

Technological innovations, such as DNA Barcoding and molecular tagging have emerged recently and facilitate the identification of food fraud. The recent horse and goat meat scandals in Europe and South Africa were identified using DNA Barcoding technology. Supply chain monitoring and industry-led certification systems, such as Vintners Quality Alliance (VQA) in the wine industry also enable quality and authenticity assurances. The study is comprised of three essays that examine authenticity issues and collective reputation in the agri-food sector.

First Essay

- Explores the concepts of food authenticity and collective reputation
- Uses the Vintners Quality Alliance (VQA) certification system in the Canadian wine industry as a case study

Research Questions

- How are quality signals used to establish authenticity assurances in agri-food markets and what are the implications for industry collective reputation?
- Is there a price premium for the VQA quality assurance on Canadian wines?

Conceptual Framework

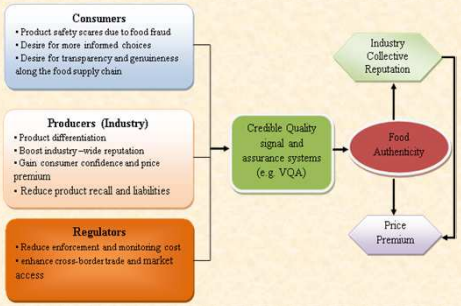


Fig.1: Conceptual framework for increased demand for food authenticity

Figure 1 shows the drivers of food authenticity claims, possible strategies to achieve credible authenticity assurances and the potential impact on the agri-food sector. Applying this to the wine industry, it shows the linkage between quality assurance (VQA) and authenticity of Canadian wines; and how authenticity could drive a price premium and boost industry collective reputation.

Analytical Technique

Data on wine prices and characteristics were obtained from the Liquor Control Board of Ontario and analysed using a Hedonic model. A hedonic function of a product relates its market price to the underlying attributes (Rosen, 1974), and is based on the notion that the market price of a good is a function of it's attributes (characteristics). Standard tests – Ramsey's RESET (Ramsey, 1969); Breusch-Pagan/Cook-Wiesberg and White's (White, 1980) tests for model specification and heteroscedasticity were used in choosing log-linear functional form to improve predictive performance.

The hedonic price equation for wine is specified as follows:

$$\ln(P) = \alpha_0 + \beta_i \mathbf{VQA} + \ln(Qty) + \ln(alcohol) + \sum_{j=1}^{J} \beta_j Colour_j + \sum_{k=1}^{K} \beta_k Varietal_k + \beta_l Sweetness_l + \sum_{m=1}^{M} \beta_m Vintage_m + \beta_q Prod.Score_q$$

Where,

Ln(P) = natural logarithm of wine price

β=% change in price of wine resulting from a unit change in an attribute

Note: exponents of estimated coefficients of dummy independent variables are used to obtain the actual (precise) % change in wine price. i.e. wine price will change by $100(e^{\beta_i}-1)$% for a unit change in an attribute, holding other factors constant.

Preliminary Empirical Results and Discussion

Table 1: Estimates for hedonic function (Pooled regression)

Variable	Level	Coefficient	Exp(coef.)	Std. error	Pr(>|t|)
Intercept		0.9776**		0.3703	0.008
VQA		0.1510***	1.1639	0.0398	0.000
Ln(quantity)		0.0257		0.0277	0.354
Ln(alcohol)		0.4983**		0.1518	0.001
Sweetness		0.0431**		0.0277	0.004
Product score		0.1274***	1.1359	0.0362	0.000
Colour/type	Icewine	2.1027***	8.1882	0.1341	0.000
	Red	0.3143*	1.3693	0.1338	0.018
	Rose	0.0314	1.0319	0.1350	0.816
	Sparkling	0.6484***	1.9124	0.1474	0.000
	White	0.2534**	1.2884	0.1325	0.006
vintage	≤ 2005	0.5473***	1.7286	0.0757	0.000
	2006	0.0920	1.0964	0.0695	0.186
	2007	0.4425***	1.5566	0.0471	0.000
	2008	0.3409***	1.4062	0.0435	0.000
	2009	0.2672***	1.3063	0.0284	0.000
	2010	0.3784***	1.4599	0.0380	0.000
	2011	0.1985***	1.2201	0.0518	0.000
	2012	0.1522	1.1644	0.0834	0.068
R^2		0.5358	n/a	n/a	n/a
F-statistics		86.10	n/a	n/a	0.000
N		1328	n/a	n/a	n/a

Notes: Significance level and codes of p-values: *=0.05, **=0.01, ***=0.001
n/a = Not applicable
Data source: LCBO (2013)

Table 2: Estimates of hedonic function – red wines

Variable	Level	Coefficient	Exp(coef.)	Std. error	Pr(>|t|)
intercept		-1.219		0.7814	0.119
VQA		0.1633*	1.1774	0.0675	0.016
Ln(quantity)		0.0505		0.0298	0.090
Ln(alcohol)		1.4730***		0.3119	0.000
Sweetness		0.0179		0.0274	0.514
	Dry	0.0655	1.0677	0.0378	0.084
	Medium dry	0.3388**	1.4033	0.1095	0.002
	Extra dry	-0.1423	0.8674	0.1190	0.232
Prod.score		0.2170***	1.2423	0.0320	0.000
Varietals	Cabernet franc	0.0075	1.0075	0.0447	0.868
	Cabernet sauvignon	-0.0231	0.9772	0.0478	0.628
	Gamay noir	0.0596	1.0614	0.0880	0.498
	Merlot	0.0052	1.0052	0.0469	0.912
	Pinot noir	0.2534***	1.2884	0.0536	0.000
	Syrah/shiraz	0.0114	1.0115	0.0683	0.867
	blend	-0.0204	0.9798	0.0439	0.642
	others	0.0557	1.0573	0.0915	0.543
Vintage	≤2005	0.7573***	2.1325	0.1382	0.000
	2006	0.1863	1.2048	0.1117	0.096
	2007	0.6059***	1.8329	0.0613	0.000
	2008	0.3892***	1.4758	0.0642	0.000
	2009	0.5637***	1.7572	0.0640	0.000
	2010	0.4048***	1.4990	0.0561	0.000
	2011	0.1448	1.1558	0.1029	0.160
R^2		0.3785	n/a	n/a	n/a
F-statistics		19.05	n/a	n/a	0.000
N		564	n/a	n/a	n/a

Notes: Significance level and codes of p-values: *=0.05, **=0.01, ***=0.001
n/a = Not applicable
Data source: LCBO (2013)

Table 3: Estimates of hedonic function – white wines

Variable	Level	Coefficient	Exp(coef.)	Std. error	Pr(>|t|)
Intercept		1.5316*		0.6594	0.021
VQA		0.2150***	1.2399	0.0484	0.000
Ln(quantity)		0.1850		0.1727	0.284
Ln(alcohol)		0.1618*		0.0676	0.017
Sweetness		0.0191**	1.0193	0.0068	0.005
	Dry	0.0643**	1.0664	0.0224	0.004
	Medium dry	0.0084	1.0084	0.0660	0.899
	Extra dry	0.0923	1.0967	0.0700	0.188
Prod.score		0.2022***	1.2241	0.0321	0.000
Varietals	Chardonnay	0.1741	1.1902	0.0752	0.021
	Gewurztraminer	-0.0314	0.9691	0.0944	0.740
	Riesling	0.1144	1.1212	0.0840	0.174
	Sauvignon blanc	-0.0155	0.9846	0.0890	0.861
	Pinot grigio	0.1862**	1.2047	0.0691	0.007
	Pinot gris	0.0981	1.1031	0.1124	0.366
	blend	0.0683	1.0707	0.0756	0.366
	others	0.0644	1.0665	0.0893	0.471
Vintage	≤ 2005	1.1155***	3.0511	0.1502	0.000
	2006	0.3032**	1.3542	0.1254	0.016
	2007	0.3964***	1.4865	0.0866	0.000
	2008	0.3854***	1.4673	0.0649	0.000
	2009	0.5049***	1.6568	0.0482	0.000
	2010	0.4911***	1.6341	0.0513	0.000
	2011	0.3093***	1.3625	0.0578	0.000
	2012	0.3091**	1.3622	0.1104	0.005
R^2		0.3288	n/a	n/a	n/a
F-statistics		16.90	n/a	n/a	0.000
N		617	n/a	n/a	n/a

Notes: Significance level and codes of p-values: *=0.05, **=0.01, ***=0.001
n/a = Not applicable
Data source: LCBO (2013)

- Analysis is ongoing. These results are preliminary
- Result of tables 1,2 and 3 show that VQA certification positively and significantly affects wine prices

Empirical Results Cont'd

- Price of VQA wines on average is 16.39% higher than non-VQA wines
- Sweetness (sugar level), alcohol content (%) and product score (quality ranking by wine experts) positively and significantly affect wine price
- VQA quality signal has established authenticity assurances, increased consumers willingness to pay for quality, and earned collective reputation for the Canadian wine industry

Second Essay

The essay explores an emerging authenticity technology, the International Barcode of Life (IBOL) and examines:

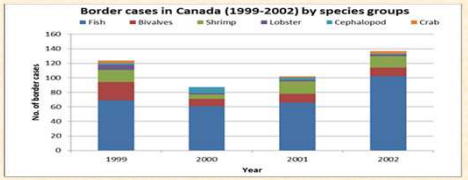
- The economic incentives for adoption of this technology in Canadian fish supply chains by private sector and regulators (e.g. CFIA),
- The potential role of IBOL in the international regulatory and governance systems involving verification of the authenticity of cross-border agricultural food products

Challenges

1.Consumers incur transaction (search) costs in search for credence attributes in the market. This results in adverse selection and payment of premium for low valued fish products.

2.Trade conflicts and border rejections due to authenticity issues

Canada



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

- 66.2% of 450 border cases involved fish

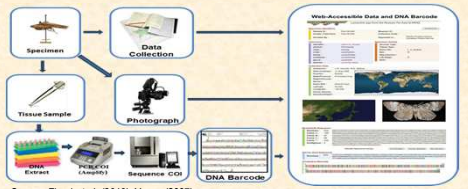
3. Existing authenticity and identification systems involve the use of:

- Morphological features, which may be absent in processed products, such as fish fillets (Wong and Hanner, 2008)
- PCR method is specie-specific and may bot be used to identify wide range of species in the market today
- Electrophoresis is protein-based and cannot be used on cooked products as protein denatures at temperatures above 80°

IBOL Technology

- Identifies fish species using DNA Barcoding

IBOL DNA barcoding process



Source: Floyd *et al. (2010)*, Yancy (2007)

IBOL and International Regulatory System

- Article 3.3 of WTO trade agreement (SPS measures) gives Member countries sovereign rights to establish their own standards and methods of product inspection based on scientific risk assessment, and should not interfere with free trade
- Absence of acceptable common scientific consensus and strong preferences have made countries to use their standards as a tool for trade restriction and protectionism

IBOL can be used as a unified regulatory protocol as:

- It is completely science based and has a common procedure, which is in line with SPS Agreement, standards, procedures and recommendations set by relevant international bodies (e.g. Codex and OIE)
- It uses reference library with common species names for easy identification, which justifies international standardization

Modeling Incentive to Adopt IBOL Technology

We model adoption decision considering two scenarios, without and with IBOL. The unregulated profit functions for both scenarios are specified as:

$$\max_{Q} \pi_{wi} = P.Q - CQ - F \qquad (1)$$

$$\max_{Q,\theta} \pi_i = [P + k(\theta)]Q - [C + j(\theta)]Q - F - Z\theta \qquad (2)$$

Where,

$\theta = 1, if\ IBOL$
$\theta = 0, if\ no\ IBOL$ – Parameter indicating adoption or non-adoption

j=variable costs associated with IBOL
P,Q= market price and quantity of fish sold
F= fixed cost with or without IBOL
C= variable costs without IBOL system
Z = fixed cost independent of number of fish tested (i.e. investment required to switch to IBOL system)

$$\Delta\pi[(2) - (1)] = (k - j)Q - Z \qquad (3)$$

Incentive to adopt will potentially occur when

$$\Delta\pi = (k - j)Q - Z \geq 0 \qquad (4)$$

Note: The analysis is on-going. A simulation model is under development.

Conclusions

- The present challenge of reputation externalities faced by food industries can be ameliorated through investment in authenticity technologies, quality assurance systems, supply chain monitoring, and credible quality signaling
- Authenticity assurances signalled by the VQA system appear to be valued, with potential implications for other agri-food sectors in establishing similar signals
- IBOL technology has the potential to be used to reduce fraud and ensure authenticity in fish markets but the benefits depend on incentives for adoption within the supply chain

References

1. Ababouch, L., Gandini, G. and Ryder, J. 2005. Causes of Detentions and Rejections in International Fish Trade.FAO Fisheries Technical Paper 473, Rome.Accessed on January 2, 2013. Available at: ftp://ftp.fao.org/docrep/fao/008/y5924e/y5924e01.pdf
2. Floyd, R., Lima, J. DeWaard, J., Humble, L. and Hanner, R. 2010. Common Goals: Implications of DNA Barcoding as a Protocol for Identification of Arthropod Pests. *Biol Invasions,* Vol. 12,(2010), pp. 2947-2954.
3. Rosen S. 1974. Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition. *Journal of Political Economy,* Vol. 82, Issue 1, pp. 34-55.
4. White, H. 1980. A Heteroscedasticity-Consistent Covariance Matrix and a Direct Test for Heteroscedasticity. *Econometrics*, Vol. 48, pp. 817-838.
5. Wong, E.H.K. and Hanner, R.H. 2008. DNA Barcoding Detects Market Substitution in North American Seafood. *Food Research International*, Vol.41, pp. 828 – 837.

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