Reputation and State Commodity Promotion: The Case of Washington Apples

Kwamena K. Quagrainie, Jill J. McCluskey, and Maria L. Loureiro

Selected paper, 2001 American Agricultural Economics Association Meetings

* Quagrainie: Post Doctoral Researcher, Department of Agricultural Economics, Washington State University. McCluskey (corresponding author): Assistant Professor, Department of Agricultural Economics, Washington State University, Pullman, WA 99164-6210. Ph. (509) 335-2835, Fax (509) 335-1173, e-mail: mccluskey@wsu.edu; and Loureiro: Assistant Professor, Department of Agricultural and Resource Economics, Colorado State University. The authors wish to thank without implicating Ron Mittelhammer and Tom Schotzko for helpful comments. This work was supported by the NRI Competitive Grant Program/USDA No. 0001853.

Introduction

Reputation plays an important role in assuring product quality in markets where consumers can only imperfectly judge the product quality until after consumption. If reputation effects are absent in these types of markets, there is an incentive for producers to reduce quality and take short-run gains before buyers catch on. In order to avoid such quality cutting, products with good reputations will sell for premium prices. Shapiro (1983) showed theoretically that price premiums are necessary for producers to invest in reputation.

There is an extensive theoretical literature on reputation[1], but empirical studies are limited. Empirical studies on the impact of firm reputation on shareholder wealth or product demand include Jarrell and Peltzman; Borenstein and Zimmerman; and Karpoff and Lott. Caves and Green showed that factors, which may affect a firm's reputation, influence the relationship between price and quality. Gorton analyzed how a bank's reputation for default affects the discount rate on its debt.

The measurement of the value of reputation to producers in terms of price premiums and how a reputation can be built up and destroyed are important issues that have not been empirically analyzed. The current study provides estimates of reputation as a dynamic latent variable that is determined by price premiums and market data. Further, it analyzes the effect of extrinsic factors on reputation. Steenkamp points out that consumers observe, at the moment of purchase, the intrinsic and extrinsic product quality cues but not the quality attributes. Intrinsic cues are characteristics of the product such as color, freshness, texture, and flavor, while extrinsic characteristics such as price of the product, store, product origin, label, and popularity of the product affect quality perceptions. Specifically, this study seeks to: (1) quantify the reputation of Washington apples over time, (2) study the dynamic nature of reputation, and (3) analyze the effect of the label "Washington Apple" on reputation.

The objectives of Landon and Smith for their empirical analysis of the effects of reputation on the hedonic price of Bordeaux wine are the closest to the objectives of this paper. They used an instrumental variables approach to obtain an expected quality variable in the hedonic price equation. Both firm and collective reputations are used as instruments. In their analysis, reputation is based on average quality ratings divided by the overall quality rating of the vintage by the *Wine Spectator* magazine and quality classifications by Parker. The major difference between the approach of Landon and Smith and this paper is that in the current analysis, reputation is estimated as a dynamic latent variable based on price premiums and marketing data rather than data provided by expert assessment. In the current analysis, both a latent structure procedure and the hedonic approach are applied to the data, and results from the two approaches are compared.

Reputation of Washington apples is examined using five major varieties of apples grown in Washington, i.e., Fuji, Gala, Golden Delicious, Granny Smith, and Red Delicious. Testable hypotheses are that lagged reputation and the "Washington Apple" logo have no effect on current reputation. Average monthly price premiums and marketing data are utilized in the study. These objectives are achieved using a two-step dynamic multiple-indicator multiple-cause (MIMIC) modeling approach (Joreskog and Goldberger), which is a special case of the general latent variable modeling scheme called "state-space" models. Since the second step of the procedure is similar to the hedonic price technique, that approach is also applied.

Although the primary purpose of this paper is to quantify reputation and understand its effect over time, a secondary contribution of this paper is that it extends the existing literature on produce marketing, specifically the marketing of Washington apples. Another contribution of this paper is the introduction of dynamics into the MIMIC framework, which is a significant departure from previous work on modeling latent structures with the exception of Richards, Gao and Patterson who used a Kalman filter in a dynamic MIMIC framework.

A Structural Latent Model of Reputation

From the theoretical literature on quality and reputation, consumers use reputation to predict quality and will pay a premium for it. In order to measure reputation over time, this paper uses the MIMIC framework for modeling latent variables based on Goldberger; Joreskog and Goldberger; and Aigner et al. Gertler provides a discussion of profit maximization and quality determination and how the MIMIC framework fits into the theoretical literature on product quality[2].

The MIMIC framework consists of two sets of relationships. In our MIMIC reputation model, the first set, which is referred to as the behavioral equation, describes how reputation changes over time and is similar to Shapiro's (1983) reputation adjustment equation (6). The equation takes the form:

(1) $$R_t = a_0 + a_1 R_{t-1} + \sum_{k=2}^{K} a_k X_t + e_t$$

where R_t is the latent (unobserved) reputation variable, and the X_t is a k x 1 vector of observable variables that determine R_t (i.e., the causes of R_t), and e_t is an independently distributed random disturbance with zero mean and finite variance (s_e^2). In this study the X_t includes the label

“Washington Apple” (logo), quarterly dummies to represent seasonality, regional dummies to represent regional differences in perceptions of quality, and apple varieties to determine the effect of each variety on reputation. Equation (1) also assumes that current reputation is a function of previous reputation R_{t-1}[3].

Patterson and Richards used a structural latent model to analyze brand attraction, a concept that is similar to reputation. The major difference between these two concepts is that, from the theoretical literature, reputation is inherently a dynamic concept while brand attractiveness is not.

The second set of relationship in the MIMIC procedure is a system of equations referred to as measurement equations that purports to measure reputation using observable variables. It consists of m variables y_t and takes the form:

(2) $$\begin{bmatrix} y_{1t} \\ \vdots \\ y_{mt} \end{bmatrix} = \begin{bmatrix} l_1 \\ \vdots \\ l_m \end{bmatrix} R_t + \begin{bmatrix} v_{1t} \\ \vdots \\ v_{mt} \end{bmatrix}$$

The y_t’s are considered as ‘indicator’ variables that provide the most direct, observable evidence of changes in the reputation variable R_t, i.e., they represent manifestations of economic factors that the reputation is intended to represent.

In terms of observable variables, the reduced form is given by:

(3) $$y_t = \Pi G_t + u_t$$

where $\Pi = \alpha\lambda'$; $G_t = R_{t-1}, X_t$; and $u_t = \lambda_t e_t + v_t$. There is one measurement equation for each of the m indicator variables, relating values of the indicators to the latent variable, cause (predetermined) variables, and a stochastic error term. The indicators y_t’s in (2) are taken to be the price premium of Washington compared with non-Washington varieties and subscripts are indexed as follows: Fuji=1, Gala=2, Golden Delicious=3, Granny Smith=4, and Red Delicious=5.

The reduced form equation, (3) resembles the standard form of a hedonic price regression except that in (3), there are five indicator equations, the dependent variables are price premiums, and the explanatory variables include lagged reputation. The hedonic price function assumes that the price of a heterogeneous good is a function of the attributes (intrinsic and/or extrinsic) of that good. The formulation is predicated on the assumption that consumers obtain utility from consuming the attributes of the good in question, i.e. that these attributes rather than the goods *per se* are the arguments in an individual's utility function. If price premiums are used as a proxy for reputation, each of the equations in (3) becomes a standard hedonic price regression.

The MIMIC procedure is covariance-oriented in that parameter estimates are obtained by minimizing the difference between the sample covariance and a fitted covariance matrix. Assuming that in equations (1) to (3) $E(X_t v_t) = 0$; $E(X_t e_t) = 0$; and $E(v_t e_t) = 0$; and $E(v_t v_t) = \Sigma$, diagonal, i.e., $\Sigma = \text{diag}(\sigma_1^2, \sigma_2^2, ..., \sigma_m^2)$, the covariance matrix of u_t in (3) is given by:

(4) $$E(u'u) = E[(\lambda_t e_t + v_t)(\lambda_t e_t + v_t)'] \equiv \Omega = \lambda\lambda' + \Sigma$$

when we adopt the normalization $\sigma_e^2 = E(e_t^2) = 1$, and where λ is a vector of indicator coefficients and Σ is a diagonal matrix of variances i.e., $\text{diag}(\sigma_1^2, \sigma_2^2, ..., \sigma_m^2)$. By adopting appropriate restrictions on Π in (3), Joreskog and Goldberger suggest an indirect estimation procedure that they called the *econometric-based* approach to estimating Π and Ω[4]. This approach has been used widely in the literature to examine several economic issues (see for example Gertler; Gao, Richards and Kagan; Gao, Wailes and Cramer; Patterson and Richards).

The solution to the above problem may be also achieved with a Kalman filter (Watson). Recent applications of the Kalman filter algorithm to estimate latent variables in agricultural economics include Chavas; Richards, Gao and Patterson; and Tegene. The Kalman Filter alogorithm was not chosen for this study because the data set is both cross-sectional and time series in contrast to the time series data sets that the Kalman filter is usually applied. If the Kalman filter procedure were applied here, either the mean of the cross section would have to be used or the estimation results would not be robust to permutations in the cross section. Therefore, an alternative two-step method of maximum likelihood is adopted to estimate the latent variable reputation[5].

The method of maximum likelihood adopted here is similar to estimating factor loadings in factor analysis (see Lawley and Maxwell, p. 10-14). Assuming that reputation R_t is known *a priori*, which satisfies the restriction Π = αλ', the log-likelihood function of (3) is of the form:

$$\text{(5)} \qquad \ln L \quad = \quad -\frac{n}{2}\ln|\Omega| - \frac{n}{2} tr(\Omega^{-1}S)$$

where $S = (1/n)(y - G\Pi)'(y - G\Pi)$; and $\Omega = \lambda\lambda' + \Sigma$. The likelihood function (5) could then be maximized to obtain optimal values of the parameters α, λ, and s_i^2. Unfortunately, the reputation variable R_t is not known and so lagged reputation R_{t-1} is also unknown. Therefore, the estimation procedure to obtain the parameters in (2) and (3), i.e., $q \equiv (a, l, s_1^2, ..., s_m^2, s_e^2)$ subject to the normalization condition $s_e^2 = 1$, is accomplished in two stages (Spanos). The first stage proceeds by ignoring the parameter restrictions P = αλ' in (3) since it includes the parameter a_1 on the unknown R_{t-1}. The indicator coefficients λ and the associated variance matrix Σ are estimated using a Multiple-Indicators (MI) model. The log-likelihood function is expressed as:

(6) $$\ln L \;=\; -\frac{n}{2}\ln|\Omega| - \frac{n}{2}tr(\Omega^{-1}S_1)$$

where S_1 = (1/n)y'y; and Ω = λλ' + Σ. The covariance matrix Ω is central to the MI estimation method. Estimates of the model parameters are found by maximizing the log-likelihood function by choosing values of λ and s_i^2 such that:

(7) $$\frac{\partial \ln L}{\partial l} = 0 \qquad \Rightarrow \qquad \hat{l} \;=\; S_1\Omega^{-1}\hat{l}$$

(8) $$\frac{\partial \ln L}{\partial s_i^2} = 0 \qquad \Rightarrow \qquad \hat{s}_i^2 \;=\; s_{ii}^1 - \hat{l}_i^2$$

where s_{ii}^1 is the i^{th} diagonal element of S_1. Note that (7) and (8) are not closed form solutions for the parameters because λ depends on s_i^2 and vice versa in both equations. To reduce the dimensionality of the numerical search for a maximum of the likelihood function, the likelihood function is concentrated by substituting $\hat{s}_i^2$ for s_i^2 in (6). Equation (6) is then maximized numerically to yield the maximum likelihood estimate of the indicator coefficients λ, which is substituted into (8) to obtain the maximum likelihood estimates of the variances s_i^2 and thus the matrices Σ and Ω.

To test the null hypothesis that $\hat{\Omega}$ provides the best estimate of the covariance matrix Ω, the test suggested by Lawley and Maxwell (p. 22) is used to test H_o: Ω = λλ' + Σ against H_a: Ω ≠ λλ' + Σ. The likelihood ratio test is of the form:

(9) $$h(d) \;=\; n[\ln|\hat{\Omega}| + tr(\hat{\Omega}^{-1}S_1) - \ln|S_1| - m] \qquad \sim \qquad c^2(d)$$

where d = 0.5m(m+1)-2m. Note that this test procedure is applied when the model is over-identified as in this study and specifically tests the statistical significance of the covariance matrix, $\Omega = \lambda\lambda' + \Sigma$. The test statistic may also be used as a test of the restriction $\Pi = \alpha\lambda'$ against $\Pi \neq \alpha\lambda'$ and can be used to assess the appropriateness of the indicators chosen.

The second step of the MIMIC estimating procedure, uses the estimators of the indicator coefficients $\hat{l}$ and the diagonal matrix $\hat{\Sigma}$ as well as the observations on price premiums y_t to estimate the reputation $R \equiv (R_1,\ldots,R_t)'$ by minimizing the sum of mean-square errors:

(10) $$l(R) = \sum_t E[(y_t - \hat{l} R_t)' \;\; \Omega^{-1}(y_t - \hat{l} R_t)]$$

(11) $$\frac{\partial \;\; l(R)}{\partial \;\; R_t} = 0 \Rightarrow \hat{R}_t = (\hat{l}\,' \;\; \Omega^{-1}\hat{l})^{-1}\hat{l}\,' \;\; \Omega^{-1} y_t$$

Spanos shows that this is a Mean Squared Estimator (MSE) of R_t, which is unbiased under the normalization $l\,'\Omega^{-1} l = 1$ because, for $\hat{R} = l\,'\Omega^{-1} y_t$, $E \;\; (\hat{R}_t - R_t) = 0, \;\forall \;\; t$. Equation (11) is used as an estimator of factor scores in the context of factor analysis as a least squares estimator when λ and Σ are known (Lawley and Maxwell). Following Spanos, the operational form of (11) is used to estimate the reputation variable R as:

(12) $$R^* = (\hat{l}\,' \;\; \Omega^{-1}\hat{l})^{-1} y \;\; \Omega^{-1}\hat{l}$$

With the estimates of R^*, the parameters in equation (1) a are estimated by regressing R^* on the cause variables G ($G_t = R_{t\text{-}1}, X_t$). We will refer to this as the *MIMIC Reputation Model*. To show that the MIMIC approach is significantly different from a standard hedonic regression, the weighted average of the price premiums $?_t$ is used as a proxy for reputation and modeled in the hedonic framework, i.e.,

(13) $$\tilde{y}_t \;\; = \;\; d_0 + d_1 \tilde{y}_{t-1} + \sum_{k=2}^{K} d_k X_t + J_t$$

We will refer to this as the *Hedonic Proxy Model*. The models represented in (6), (12) and (13) are estimated using GAUSS 3.5.

Data

Data used are monthly regional market data rather than survey data in order to recover the reputation of Washington Apples. The Washington Apple Commission is the source of the data. The data in its original form is cross-sectional daily observations from a number of cities, which spans four years, from July 1996 to November 1999. It contains observations from major cities in every state in the continental United States on five varieties of apples: Fuji, Gala, Golden Delicious, Granny Smith, and Red Delicious. The data include advertised retail prices of Washington apples and non-Washington apples, and whether there was a "Washington Apple" logo on apples from Washington. The nation was demarcated into five regions, i.e., Midwest, Northeast, Southeast, Southwest and West. Then the data was averaged across cities per month, to obtain average regional monthly series for each variety. The data utilized in the study thus include price premiums of each variety (Washington to non-Washington), variety variables, and a logo variable. The variables, descriptions and summary statistics are presented in Table 1. Seasonal and regional variables are also included in the model as [0, 1] dummies.

Results and Discussion

Results from the first stage of the estimation procedure are reported in Table 2. The estimates of the five indicator coefficients λ corresponding to the five varieties are 0.05, 0.06, 0.06, 0.05 and 0.16 for Fuji, Gala, Golden Delicious, Granny Smith and Red Delicious respectively. All estimates have positive signs and are highly significant, suggesting that price premiums are good indicators of the reputation that consumers have for Washington apples. The results that the indicator coefficients, also called factor loadings, are positive and significant imply that what the indicators have in common is the reputation that we intended to measure. Therefore, the measurement of reputation is not likely to be obscured by a wide diversity in the price premiums. The common factor issue suggests that a possible collective reputation effect exists (Tirole). The positive sign on all the indicator coefficients also brings out the complementary relationship between these price premiums. It implies that simple aggregates of these price premiums could be used as measures (proxies) for reputation, which could be a justification for the second model, the Hedonic proxy model. Notwithstanding, results from the MIMIC reputation model make more intuitive sense and are consistent with the theoretical literature on reputation than the results from the Hedonic proxy model. The estimates for the corresponding variances, Σ_{ii}, of the indicator coefficients are also statistically significant (see Table 2).

Since the MIMIC approach relies on covariance relationships, the statistical significance of the fitted covariance matrix $\Omega = \lambda\lambda' + \Sigma$, was tested using equation (9). The likelihood ratio test statistic, $h(5)$ is 1.137 and P-value is 0.951; values that are well within the acceptance region of a five percent test, leading us not to reject the null hypothesis that $\hat{\Omega}$ provides the best estimate of Ω.

Table 3 presents the results from the second stage of the MIMIC reputation model as well as results from the Hedonic proxy model. Results from the reputation model indicate statistical significance of eleven out of fourteen estimated parameters while in the Hedonic proxy model, nine estimated parameters are deemed statistically significant at the five percent level.

We hypothesized that lagged reputation affects current reputation because current posterior beliefs about reputation are a function of prior beliefs, i.e., reputation is a dynamic concept (Shapiro, 1982, 1983). As expected, the parameter estimate on the lagged reputation variable is positive and significant, which corroborates theoretical results from Shapiro (1983), and empirical findings of Mannering and Winston, and Thomas. In order to evaluate whether reputation is nonstationary, and that shocks to reputation are permanent, we tested whether the coefficient on the lagged reputation variable is equal to one. Based on the results of an F-test statistic of 411.8, we reject this hypothesis at the five percent level, which leads us to conclude that reputation does evolve over time, and that shocks to reputation are temporary and dampen over time. It also implies that reputation is a stationary time series process. Similar conclusions could be drawn from the Hedonic proxy model since the lagged proxy price premium variable is also positive and significantly different from unity.

State promotion of different commodities has been used as a marketing strategy to differentiate products in order to enhance the reputation of specific states' agricultural products. Early efforts of state promotion include Washington apples, Florida citrus, and Idaho potatoes. However, not all the implemented state promotion programs have counted on historical reputation as an asset or informational leverage. As a result, some efforts at promotion of state products have been more successful than others. It appears from the results that the apple industry in Washington benefits from built-up reputation from the past.

Regarding seasons, all estimates in the MIMIC reputation model are positive and are statistically significant except the estimate on the fourth quarter, which is not significant. The parameter estimates on the first, third and fourth quarters are 0.142, 0.188 and 0.078 respectively, and represent seasonal effects on reputation relative to the second quarter base (Table 3). The fourth quarter of the year is when apples are in season, and the third quarter is the period when most of the fruits on sale have been in storage for a long time. A positive sign for the third quarter suggests a positive seasonal effect on reputation relative to the second quarter.

Thus, the positive sign on these seasonal parameters reflects consistency in expected quality of Washington apples irrespective of the season. This is consistent with expectations regarding the reputation of Washington apples.

In the Hedonic proxy model however, the signs on estimated coefficients on the quarters reflect more on the trend in apple prices over time. For example, estimates in the first and fourth quarters have negative signs –0.025 and –0.016 respectively, while the estimated coefficient on the third quarter has a positive sign 0.018 (Table 3). All estimated coefficients are statistically significant implying that the effects of the first and fourth quarters are negative but the effect of the third quarter is positive relative to the base quarter. These results do not make intuitive sense in terms of reputation. In terms of price trend however, the results make perfect economic sense when we consider that the price of apples will be higher as we move away from the apple season. Thus, we expect that the coefficient on quarter three will be positive, relative to quarter two and similarly, the coefficients on quarters one and four will be negative relative to quarter two.

Regional variables were included in the model to capture the regional differences in perceptions of quality of Washington apples. In the MIMIC reputation model, all parameter estimates are positive and significant. The positive sign on the estimated parameters represent regional perceptions of quality relative to the western region base. The Midwest and Southwest regions appear to have relatively, higher perceptions of quality for Washington apples compared to the Northeast and Southeast regions. The differences in magnitude of parameters could be a reflection of regional identities. The Northeast, particularly New York and Pennsylvania, produces a fair amount of apples and the Southeast, particularly Florida, is the home to the production of fruits that could be considered as substitutes to apples. The regional parameter differences could also be attributed to differences in transportation and storage costs on price premiums. In the Hedonic proxy model however, the signs on the estimated coefficients on the regional dummy variables are mixed. Coefficients on the Midwest and Southeast regions have negative signs while coefficients on Northeast and Southwest regions have positive signs. Only the coefficient on Southwest is deemed significant.

Washington State benefits from the reputation that its producers grow high quality apples. In recent years, however, there have been industry concerns regarding the declining "eating" quality of Washington Red Delicious apples. This is expected to have a negative effect on the reputation of Washington apples and consequently on demand. The varieties of apples included as explanatory variables of reputation include Fuji, Golden Delicious, Granny Smith and Red Delicious. In the MIMIC reputation model, all estimated parameters had a positive sign except the coefficient on the Red Delicious. Estimated coefficients are 1.873, 0.872, 0.12, and –0.378 for Fuji, Golden Delicious, Granny Smith and Red Delicious respectively (Table 3). Given the concerns in the industry regarding declining "eating" quality of the Red Delicious, the negative sign is not unexpected though the estimate is not significant at conventional levels. The Fuji and Golden Delicious are found to enhance reputation of Washington apples. Generally, the signs on the estimated parameters in the reputation model are in line with industry expectations.

In the Hedonic proxy model coefficient estimates on Fuji and Red Delicious have positive signs, 0.03 and 0.354 respectively, but coefficient estimates on Golden Delicious and Granny Smith have negative signs, –0.295 and –0.138 respectively. The estimates on Red Delicious, Golden Delicious and Granny Smith are statistically significant. The Red Delicious variety is considered the least desirable, and it is surprising to find a statistically significant positive estimate in the Hedonic proxy model while the Granny Smith, a more desirable variety, is found to have a significant negative coefficient.

The inconsistency in signs on the parameters from the Hedonic proxy model, and the apparent lack of empirical interpretations for the parameters corroborate the assertion that inappropriate specification of a latent variable invokes “measurement errors” and can seriously distort empirical interpretations (Gao, Wailes and Cramer; Patterson and Richards).

According to the Washington Apple Commission, the use of the “Washington Apple” logo is aimed at increasing consumer awareness of Washington apples and as a signal of quality. Therefore, we expected the parameter estimate on this variable to be positive. The logo coefficient is positive and significant, suggesting its significance for reputation. The magnitude of the effect of the logo variable is relatively large compared to the other cause variables in the reputation model. This strengthens the reasons to use the “Washington apple” logo as a quality signal. The “Washington Apple” logo in its current version has been used by the Washington Apple industry on all fresh Washington apples since 1982 as a seal of guaranteed quality.

The presence of the logo on fruits and fruit packages only signals origin and does not reflect specific quality or production standards. Some Washington apple producers use their own logo in addition to the “Washington Apple” logo to differentiate their apples. Shipping organizations may also have the logo imprinted on the container. There are no rules for quality control for Washington producers other than the apples must be grown in Washington State. Producers, therefore, have large incentives to produce low quality products and still benefit from the collective reputation that Washington has built up over time. The estimated coefficient on logo in the Hedonic proxy model is also positive and significant but the magnitude is relatively small when compared to the magnitude of other estimated coefficients in the model.

Patterson and Richards (P&R) analyzed the effect of the “Washington Apple” logo on apple sales with both a static structural latent model and a LAIDS model. With the former model, P&R found that the logo had no impact on sales, but logo was positive and significant in the LAIDS model. A possible reason for the different results in the structural latent model of P&R and that of this study are that, P&R analyzed the effect of brand attraction on the price level, while the current analysis considers the effect of reputation on price premiums. In addition, the latent variable brand attraction of P&R is applied to the entire apple industry, while our latent variable reputation applies only to Washington apples, a specific state's commodity.

The estimated constant term in the reputation model is –2.199, which is greater than all other estimated parameters, and is strongly significant. This suggests a declining trend in reputation. An important question is how long can Washington apple producers enjoy a reputation for quality if the current trend continues? With perfect information and perfect competition, one would expect consumers to substitute apples from other sources for Washington apples if the expected quality falls below consumers' preferred quality. However, with about sixty percent of all apples grown for the U.S. fresh market originating from Washington State, substituting to other apple sources is unlikely. Instead, if the expected quality falls below consumers' preferred level of quality, consumers will no longer be willing to pay a premium for Washington apples.

According to the standards currently used by the apple industry (such as size and appearance), Washington apples are generally considered the best and are above the USDA quality standards. The problem may be that quality standards need to include some intrinsic factors such as taste, texture and flavor. The apple industry's emphasis on fruit appearance rather than taste, texture and flavor could drive consumers to substitute away from apples to other fruits. Shapiro (1983) points out that minimum quality-standards can influence the equilibrium price-quality schedule so that for consumers' expectations of quality to be fulfilled, it can be desirable to impose a minimum standard. In order to maintain its good reputation, the apple industry in Washington should consider establishing minimum standards for what constitutes “eating quality” in addition to the normal grading. This may suggest that reputation should be considered in any cost-benefit analysis for the industry. Loureiro and McCluskey found that if the protected geographical indications label “Galician Veal” from Spain was present on meat products, Spanish consumers were willing to pay a significant premium. The use of the “Galician Veal” label requires producers to be located in the region and also meet very strict quality and production practice standards.

Conclusions

A dynamic multiple-indicator multiple-cause (MIMIC) framework was used to estimate the latent variable reputation with price premiums for Washington apples and attributes that covered the period July 1996 to November 1999. A maximum likelihood two-stage approach was employed. For comparison purposes, a hedonic regression was also estimated.

Results from the first stage of the estimation procedure in the MIMIC reputation model suggest that price premiums are good indicators of reputation. The indicator coefficients, also called factor loadings, imply that the estimated reputation variable is common to the five indicators chosen and that the measurement of reputation is not likely to be obscured by a wide diversity in the indicators. The common factor issue suggests a possible existence of collective ‘Washington’ reputation.

Results from the second stage of the MIMIC reputation model are compared to those from the Hedonic proxy model. In general, results from the MIMIC reputation model make more intuitive sense and are in line with the theoretical literature on reputation than the results from the Hedonic proxy model. Reputation is found to be stationary and that shocks to Washington's reputation are temporary. In the MIMIC reputation model, all the estimated coefficients on the explanatory cause variables had positive signs, except the Red Delicious variety variable. The magnitude of the coefficient on the logo term is large, suggesting a strong impact on reputation. The estimated constant term in the MIMIC reputation model is negative and relatively large, which suggests that reputation is declining. The concerns of declining perceived "eating" quality in Washington varieties thus appear to be real. It appears then that the apple industry is currently benefiting from past/accrued reputation. The current standards in the apple industry give room for some Washington producers to free ride on the collective reputation. Hence, there may be some justification for minimum quality standards. For efficient public policy purposes, our findings suggest that policymakers and the apple industry as a whole should consider reputation in their cost-benefit analysis for purposes of resource allocation.

Endnotes

[1]See for example, Allen; Klein and Leffler; Kreps and Wilson; Milgrom and Roberts; Rogerson; Shapiro (1982, 1983); Tirole; and Tadalis

[2]For a rigorous formulation of product quality and market analysis, see Leffler.

[3]Shapiro (1983) and results in Mannering and Winston suggest a lagged reputation effect. Thomas includes a previous performance period measure in a hedonic price regression, although not explicitly as a proxy for reputation.

[4]In the *econometric-based* approach of Joreskog and Goldberger, several restrictions are imposed on the reduced-form functions to identify the structural equations. The restrictions are often tested using a minimum-distance statistic as in Gao, Richards and Kagan; Gao, Wailes and Cramer; Gertler.

[5]Other methods for estimating the latent variable series from the structural model include the EM algorithm (Chen), method of scoring (Watson and Engel), "smoothing" (Harvey), and Generalized Maximum Entropy (McCluskey and Rausser).

References

Aigner, D., C. Hsaio, A. Kapteykn, and T. Wansbeek. “Latent Variable Models in Econometrics,” in *Handbook of Econometrics*, Vol. 2., eds. Z. Griliches amd M. Intriligator, Amsterdam: North-Holland, 1984.

Allen, F. “Reputation and Product Quality,” *The Rand Journal of Economics*, 15 (Autumn 1984):311-27.

Borenstein, S. and M.B. Zimmerman. “Market Incentives for Safe Commercial Airline Operation.” *American Economic Review* v78 (December 1988): 913-35.

Caves, R.E and D.P. Greene. “Brands' Quality Levels, Prices, and Advertising Outlays: Empirical Evidence on Signals and Information Costs.” *International Journal of Industrial Organization* v14 (February 1996): 29-52.

Chavas, J.P. “Structural Change in the Demand for Meat.” *American Journal of Agricultural Economics*, 65 (February 1983):148-153.

Chen, C.F. “The EM Approach to the Multiple Indicators and Multiple Causes Model via the Estimation of the Latent Variable.” *Journal of the American Statistical Association*, 76 (September 1981):704-708.

Gao, X.M., T.J. Richards, and A. Kagan. “A Latent Variable Model of Consumer Taste Determination and Taste Change for Complex Carbohydrates.” *Applied Economics*, 29 (December 1997):1643-1654.

Gao, X. M., M.E.J. Wailes, and G.L. Cramer. “A Microeconomic Analysis of Consumer Taste Determination and Taste Change for Beef.” *American Journal of Agricultural Economics*, 79 (May 1997):573-582.

Gertler, P.J. "A Latent-Variable Model of Quality Determination." *Journal of Business and Economic Statistics*, 6 (January 1988):97-104.

Goldberger, A.S. "Structural Equations in the Social Sciences" *Econometrica*, 40 (November 1972):979-1001.

Gorton, G. "Reputation Formation in Early Bank Note Markets." *Journal of Political Economy* 104 (April 1996): 346-97.

Harvey, A.C. *Structural Time Series Analysis and the Kalman Filter*. Boston: Cambridge University Press, 1989.

Jarrell, G. and S. Peltzman. "The Impact of Product Recalls on the Wealth of Sellers," *Journal of Political Economy*, 93 (June 1985): 512-36

Joreskog, K., and A.S. Goldberger. "Estimation of a Model with Multiple Indicators and Multiple Causes of a Single Latent Variable." *Journal of the American Statistical Association*, 70 (September 1975):631-639.

Karpoff, J.M. and J.R. Lott Jr. "The Reputational Penalty Firms Bear from Committing Criminal Fraud." *Journal of Law and Economics* 36 (October 1993): 757-802

Klein, B. and K.B. Leffler. "The Role of Market Forces in Assuring Contractual Performance," *Journal of Political Economy*, 89 (August 1981):615-641.

Kreps, D. and Wilson, R. "Reputation and Imperfect Information." *Journal of Economic Theory* 27 (August 1982):253-279.

Landon, S. and C.E. Smith. "Quality Expectations, Reputation, and Price," *Southern Economic Journal*, 64 (January 1998):628-47.

Lawley, D.N., and A.E. Maxwell. *Factor Analysis as a Statistical Method*, 2nd edition, London, Butterworth, 1971.

Leffler, K.B. “Ambiguous Changes in Product Quality.” The American Economic Review, 72 (December 1982):956-967.

Loureiro, M.L. and J.J. McCluskey. “Assessing Consumers Response to Protected Geographical Identification Labeling,” *Agribusiness: An International Journal*, 16 (Summer 2000):309-320.

Mannering, F. and C. Winston. “A Dynamic Empirical Analysis of Household Vehicle Ownership and Utilization.” *Rand Journal of Economics*, 16 (1985):215-236.

McCluskey, J.J. and G.C. Rausser. “Estimation of Perceived Risk and its Effect on Property Values.” *Land Economics*, 77 (2001):42-55.

Milgrom, P. and J. Roberts. “Predation, Reputation, and Entry Deterrence.” *Journal of Economic Theory*, 27(August 1982):280-312.

Parker, R.M. *Bordeaux*, New York: Simon & Schuster, 1991.

Patterson, P.M. and T.J. Richards. “Newspaper Advertisement Characteristics and Consumer Preferences for Apples: A MIMIC Model Approach.” *Agribusiness: An International Journal*, 16 (Spring 2000):159-177.

Richards, T.J., X.M. Gao, and P.M. Patterson. “Advertising and Retail Promotion of Washington Apples: A Structural Latent Variable Approach to Promotion Evaluation.” *Journal of Agricultural and Applied Economics*, 31 (April 1999):15-28.

Rogerson, W.P. “Reputation and Product Quality.” *The Bell Journal of Economics*, 14(Autumn 1983):508-516.

Shapiro, C. “Consumer Information, Product Quality, and Seller Reputation.” *The Bell Journal of Economics*, 13(Spring 1982):20-35.

_________. “Premiums for High Quality Products as Returns to Reputation.” *The Quarterly Journal of Economics*, (November 1983):659-679.

Spanos, A. “Liquidity as a Latent Variable – An Application of the MIMIC Model.” *Oxford Bulletin of Economics and Statistics*, 46 (February 1984):125-143.

Steenkamp, J-B.E.M. “Conceptual Models of the Quality Perception Process.” *Journal of Business Research*, 21 (1990):309-333.

Tadalis, S. “What is a Name? Reputation as a Tradable Asset.” *The American Economic Review*, 89 (June 1999):548-563.

Tegene, A. “The Kalman Filter Approach for Testing Structural Change in the Demand for Alcoholic Beverages in the US.” *Applied Economics*, 22 (October 1990): 1407-1416.

Thomas, J.M. “The Implicit Market for Quality: A Hedonic Analysis.” *Southern Economic Journal*, 59 (1993):648-674.

Tirole, J. “A Theory of Collective Reputations: Applications to the Persistence of Corruption and to Firm Quality.” *Review of Economic Studies*, 63 (January 1996):1-32.

Watson, M.W. and R.F. Engel. “Alternative Algorithms for the Estimation of Dynamic Factor, MIMIC and Varying Coefficient Regression Models.” *Journal of Econometrics*, 23 (December 1983):385-400.

Watson, P.K. “Kalman Filtering as an Alternative to Ordinary Least Squares – Some Theoretical Considerations and Empirical Results.” *Empirical Economics*, Vol. 8 #2, (1983):71-85.

Table 1: Variable Descriptions and Summary Statistics

Variable	Description	Mean	Std. Deviation
Fuji Price	Price premium/pound of Fuji	0.034	0.085
Gala price	Price premium/pound of Gala	0.008	0.104
Golden Delicious price	Price premium/pound of Golden Delicious	0.093	0.054
Granny Smith price	Price premium/pound of Granny Smith	0.042	0.064
Red Delicious price	Price premium/pound of Red Delicious	0.259	0.103
Fuji	Fuji variety	0.082	0.077
Gala	Gala variety	0.099	0.066
Golden Delicious	Golden Delicious variety	0.149	0.079
Granny Smith	Granny Smith variety	0.105	0.058
Red Delicious	Red Delicious variety	0.438	0.128
Presence of logo	Presence of logo	0.585	0.181
Reputation	Estimated measure of reputation	0.949	0.823

Table 2: Results from Stage 1 – Log likelihood estimates

Parameter[a]	**Estimate**	**Asymptotic t-statistics**
λ_1	0.053	12.149
λ_2	0.061	12.229
λ_3	0.063	14.051
λ_4	0.045	7.944
λ_5	0.164	12.562
Σ_{11}	0.005	11.894
Σ_{22}	0.007	15.184
Σ_{33}	0.008	80.232
Σ_{44}	0.004	5.401
Σ_{55}	0.051	18.038

[a] The variety associated with each parameter is indexed 1=Fuji, 2=Gala, 3=Golden Delicious, 4=Granny Smith, and 5=Red Delicious.

Table 3: Estimates from the MIMIC Reputation Model (Stage II) and the Hedonic Proxy Model

	MIMIC Reputation Model		Hedonic Proxy Model	
Variable	**Estimate**	**t-statistic**	**Estimate**	**t-statistic**
Constant	-2.199	-11.837	0.004	0.150
Lagged dep. variable	0.137	3.210	0.140	3.311
Quarter 1	0.142	1.877	-0.025	-2.651
Quarter 3	0.188	2.726	0.018	1.982
Quarter 4	0.078	1.114	-0.016	-1.867
Midwest	0.387	4.678	-0.009	-0.860
Northeast	0.267	3.443	0.010	1.065
Southeast	0.158	1.822	-0.019	-1.759
Southwest	0.362	4.568	0.026	2.520
Fuji	1.873	4.505	0.030	0.556
Golden Delicious	0.872	2.167	-0.295	-5.613
Granny Smith	0.120	0.237	-0.138	-2.115
Red Delicious	-0.378	-1.229	0.354	8.912
Presence of Logo	1.883	15.026	0.049	3.694
# of observations:	200		200	
R^2	0.869		0.763	