Collective Reputation and Quality

Jason A. Winfree and Jill J. McCluskey

Firms who sell regional or specialty products often share a collective reputation based on aggregate quality. Collective reputation can be approached as a dynamic common property resource problem. We show that for an experience good without firm traceability, individual firms have the incentive to choose quality levels that are sub-optimal for the group. These results support minimum quality standards. Trigger strategies are analyzed as an alternative solution to this problem. Finally, the implications of these results are discussed as they relate to the case study of Washington apples.

Key words: collective reputation, specialty products, Washington apples.

Specialty, regional, authentic, and local food products have become a more important part of consumer purchases in recent years. Firms have responded by marketing food products that come from specific geographic areas. This trend in consumers' preferences has led the European Union to introduce protected designations of origin labels and protected geographical identification labels, which provide protection of food names on a geographical or traditional basis, ranging from Parmesan cheese to such lesser-known items such as Galician veal. In the United States, there are popular state products that carry labels, such as Washington apples, Idaho potatoes, and Florida oranges.

One determinant of the success of specialty or local products is the collective reputation of the product. When the collective reputation of the product is good, the designation will be a powerful tool to signal quality. Tirole (1996) modeled the idea of collective reputation as a function of individual reputations. The concept of collective reputation is important for many food products, where the individual producers are not known directly by the consumer. Because food products are typically experience goods, the consumer relies on the reputation of the producer group, cooperative, or consortia that guarantees and promotes the particular product.

In this article, the reputation of the product is assumed to be similar to a common property resource, which is exclusive to the group of firms that are marketing the product. In the spirit of Tirole's (1996) idea of collective reputation, it is assumed that the firms in the group share a common reputation, which is based on the group's *past* average quality. Because reputation is a dynamic concept, we can apply tools from differential game theory. The dynamic problem of collective reputation is similar to the common property natural resource extraction problem studied by Levhari and Mirman and many others.

As Karp points out, if there is unrestricted access to a natural resource, agents perceive its shadow value to be zero and extract too rapidly, that is, "cheat" on quality, "milking" the rents generated by the existence of the resource. However, when access is restricted to a finite number of firms, additional dynamics may exist. We show that if there is asymmetric information about individual firm quality, all firms will "extract" from the stock of reputation. A firm is said to "extract" reputation from the reputation stock at time t when it sells low-quality products at high prices determined by the high past levels of quality. The firm builds on the group's reputation when it provides a product with a quality level which is higher than the expected level of quality.

A main result and contribution of this article is that as the number of firms in the producer group increases, the incentives to provide quality decreases. Further, we show that with collective reputation (i.e., without quality traceability to specific firms), minimum

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quality standards can be Pareto improving for firms. Alternatively, we show how trigger strategies could be implemented by the group of firms to maintain quality. The article proceeds as follows. We provide a brief literature review of related studies, followed by a presentation and analysis of the theoretical model using differential games. Next, we provide a discussion of the Washington apple industry in light of our analytical findings. Finally, conclusions and policy implications are presented.

Related Literature

Collective reputation is important for food products because they can be generally classified as "experience goods," which are goods whose quality is unobservable until they are consumed. There is empirical evidence that collective reputation is an important factor in determining price premiums. Landon and Smith find that reputation is a significant factor in determining price premiums for wine; Quagrainie, McCluskey, and Loureiro (QML) find that a common reputation exists and has a positive effect on the price of Washington apples relative to apples from other states.

Market imperfections for experience goods were first identified by Nelson, and there has been a great deal of work in this area (see Tirole 1992, for a survey). Riordan argues that if firms are able to signal quality for experience goods, or consumers make repeat purchases, the lemons problem will be less severe. Gale and Rosenthal find that firms who produce experience goods will build a reputation and eventually extract their reputation and produce low-quality goods.

Although many researchers have analyzed firm-specific reputations, only a few have focused on collective reputation. The major contribution is the matching game of Tirole (1996) with overlapping generations to consider the persistence of corruption in groups and firm quality, where the firm should be thought of as the aggregate of individual workers. A group member's past quality is only observed with noise, and each group member's incentives is affected by both his/her own past quality and the group's quality. Tirole (1996) finds that new members of an organization may suffer repercussions from their elders' corruption long after the latter are gone. An important result from his paper is that a low (high)-corruption steady state only occurs when information about individual quality is good (poor). Tirole (1996) does not consider the size (number of group members) of the group. In the current article, we derive a result based on group size and argue that the number of producers is especially important for quality providing incentives in agriculture. Further, Tirole's (1996) informational assumptions are different from the current article. We assume that there is no firm-level quality traceability, which leads to different conclusions from previous work.

Some of the ideas of collective reputation are reminiscent of those in the generic advertising literature, although to our knowledge the theoretical literature in commodity promotion is not dynamic in nature. Many generic commodity programs require producers to contribute money towards promotion. The argument is that without mandatory assessments, there is an incentive to free ride on the benefits of increased demand for the commodity in question. As with our results, the ability to differentiate one's product (traceability in our context) matters. If a product can be differentiated based on the firm that supplies it, as with branded commodities, then the usual results do not apply. Crespi and Marette show that if the benefits from generic advertising are outweighed by the costs from lower product differentiation, then high-quality producers will not benefit from generic commodity promotion.

Model

Food products are generally experience goods, as they are largely valued for eating quality, including taste and "mouth feel," and nutrition, which cannot be evaluated based on appearance alone. The analysis of the quality choice in a market for an experience good by producers who cannot differentiate their product at the firm level (i.e., there is no firm-level traceability) must include certain informational assumptions. First, current quality (neither firm-level nor average quality) is unobservable before purchase. Secondly, consumers observe average quality with a lag and use reputation (based on past average quality) to predict current quality.

For our analysis of collective reputation, we use a differential game. Following the standard game theoretic-optimal control setup, when choosing his or her strategy, each producer is aware of the other producers and how the other producers' choices of their control variables affect his or her payoffs. That is, all players choose their control variables simultaneously. Each producer knows the others' strategies. When there is no incentive for any of the producers to revise his or her choice of control variable, then the choices are said to be in equilibrium.

We assume there are N identical firms that produce a specialty product with no entry or exit. Each of the firms is risk neutral and maximizes profits. At each point in time, the product's collective reputation, R, determines the location of its (inverse) demand curve, $p(R)$. Note that reputation is for the industry as a whole but not for each firm, implying that there is no traceability. We assume that collective reputation evolves as a Markovian process of past reputation and the present quality produced. In order to focus on the firm's quality decision, we assume that each firm produces a fixed quantity in each period and, for simplicity, the quantity produced is assumed to be one unit. We will assume that, for an N firm industry, each firm chooses quality to maximize profits over time subject to the state equation for reputation:

$$(1) \qquad \max_{q_i \geq 0} \int_0^\infty e^{-rt} \left[p(R) - c(q_i)\right] dt \qquad i = 1, \ldots, N$$

subject to

$$(2) \qquad \dot{R} = \gamma \left(\sum_{j=1}^{N} \left(\frac{q_j}{N}\right) - R \right) \qquad R(0) = R_0 > 0$$

where R is the collective reputation, and q_{i} is firm i's quality choice. The term $\sum_{j=1}^{N} (q_j/N)$ is the average industry quality. These values are normalized so that they are in the same units. Price is denoted as p, costs are denoted as c, the discount rate is r, time is represented by t, and γ represents the "speed of consumer learning" (Shapiro). This parameter represents the time lag after purchase before the market learns about average quality. We assume the standard structural forms so that $p'(q) > 0$, $c'(q) > 0$, $c''(q) > 0$, and $c''(q) > p''(q)$. We assume that the firm's quality level will react to the reputation level, therefore a closed-loop equilibrium is needed. We also assume that player, i, believes that all other players use a stationary Markovian strategy $q_j = \phi(R)$, $j \neq i$, so that $\sum_{j=1}^{N} (q_j/N)$ can be represented by $q_i/N + [(N-1)/N]\phi(R)$ in firm i's Hamiltonian. The current-value Hamiltonian for each firm in a noncooperative game is given by

$$(3) \qquad \tilde{H}_i = [p(R) - c(q_i)] + \lambda_i \gamma \left[\frac{q_i}{N} + \left(\frac{N-1}{N}\right) \phi(R) - R \right]$$

where λ_i represents the shadow price of reputation that also takes into account the discount factor.

The first-order conditions of the current-value Hamiltonian for the differential game are as follows:

$$(4a) \qquad c'(q_i) = \frac{\lambda_i \gamma}{N}$$

$$(4b) \qquad \dot{\lambda} = -p'(R) + \lambda_i \left[\gamma + r - \frac{\gamma(N-1)}{N} \phi'(R) \right]$$

$$(4c) \qquad \dot{R} = \gamma \left(\frac{q_i}{N} + \left(\frac{N-1}{N}\right) \phi(R) - R \right).$$

Taking the derivative of equation (4a) with respect to time and substituting it into equation (4b), we obtain

$$(5) \qquad \dot{q} = \frac{\left\{ \begin{matrix} c'(q)\left[r + \gamma - (\gamma(N-1)/N)\phi'(R)\right] \\ -\gamma p'(R)/N \end{matrix} \right\}}{c''(q)}.$$

Steady-state solutions occur at the intersection of $\dot{R} = 0$ and $\dot{q} = 0$, which are the zero-change isoclines. As all firms are identical, $q_i(R) = \phi(R)$. Therefore, the change in reputation is equal to $\gamma[\phi(R) - R]$, and in a steady-state equilibrium, $\phi(R) = R$. This implies that in the steady state, the industry reputation is equal to the firm quality. Taking the derivative, $\phi'(R) = 1$. Thus, by setting $\dot{q}$ equal to zero, we can find the equilibrium

$$(6) \qquad p'(R^*) = \left(1 + \frac{rN}{\gamma}\right) c'(q^*)$$

where R^* and q^* represent the noncooperative equilibrium reputation and quality levels. The local stability properties of the steady state are found by using the Jacobian matrix. The

Jacobian matrix is given by

$$(7) \qquad J = \begin{bmatrix} \frac{\partial \dot{R}}{\partial R} & \frac{\partial \dot{R}}{\partial q} \\ \frac{\partial \dot{q}}{\partial R} & \frac{\partial \dot{q}}{\partial q} \end{bmatrix}_{q^*,R^*} = \begin{bmatrix} -\gamma & \gamma \\ \frac{-\gamma p''(R^*)}{Nc''(q^*)} & \frac{\gamma}{N} + r \end{bmatrix}$$

and the characteristic polynomial is given by $\mathrm{CP}(E) = E^2 - \mathrm{Tr}(J)E + \mathrm{Det}(J) + 0$, where E are the eigenvalues, Tr is the trace, and Det is the determinant. The determinant of the Jacobian matrix can be shown to be negative, which implies eigenvalues of opposite sign. This shows that the solution of the differential equations involves a saddle-point equilibrium.

We can also evaluate whether increasing the number of firms implies that quality will decrease. If we take the implicit derivative of quality with respect to number of firms at the equilibrium point, we obtain

$$(8) \qquad \frac{dq^*}{dN} = \frac{rc'(q^*)}{\gamma p''(q^*) - (\gamma + rN)c''(q^*)}.$$

This expression has a negative value, which implies that as the number of firms increases, the average quality decreases. The rationale for this result is that if there is an increase in the number of firms, individual firms benefit less from providing high quality, but each firm still incurs the same cost for high quality. In other words, when the returns to quality are diluted but the costs are not, firms have a lower incentive to provide quality. The assumption that there is no traceability is critical to the results of this model. If there is traceability, then firms may be able to differentiate their products and obtain undiluted returns to quality investments. A result similar to that derived in equation (8) has been discussed in the content of renewable natural resources. Dockner et al. show (implicitly) that in a renewable resource differential game, the equilibrium stock decreases as the number of harvesters increases.

A single firm should be considered as the benchmark case. This is the equivalent of a cooperative path. If there is one firm in the industry, it maximizes its own profits, which are also the industry's profits, by definition, there can be no free riding. When an additional firm enters the industry, there is a duopoly, and now the collective reputation depends on both firms' quality choices. As the individual firm's returns to quality are now diluted, each firm

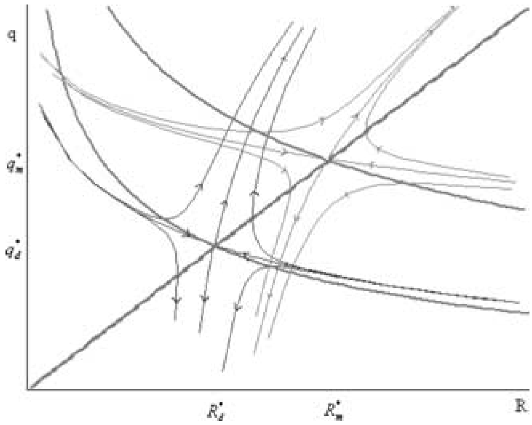


Figure 1. Phase diagram. The subscript *d* denotes the doupoly equilibrium, and the subscript *m* denotes the monopoly equilibrium

provides a lower level of quality. As an example, in figure 1, we present the phase diagram with equilibria for both the monopoly (one firm) and duopoly (two firm) cases. From figure 1, we observe that the quality and collective reputation are lower with duopoly than with monopoly, as the number of firms increase, the steady-state quality and reputation decrease.

Minimum Quality Standards

This model has implications for enforceable minimum quality standards for producer groups and regional and specialty products. If q_{mt} is the monopolists' profit-maximizing quality, at time t, then it is the industry profit maximizing quality. If the number of firms in the industry, N, is greater than one, then collectively it is in the industry's best interest to restrict quality so that $q_t \geq q_{mt}$, for example, a minimum quality standard. This minimum quality standard would have to be imposed early in the supply chain, as the producer relinquishes his or her product.

This constraint will be binding because quality decreases as the number of firms increases as shown in equation (8). This restriction eliminates free riding and results in a better collective reputation. This leads to a Pareto improvement for all firms compared with the multiple-firm (Cournot–Nash) equilibrium. This is analogous to a cartel engaging in profit maximization by limiting its collective output to the monopoly level.

Our conclusions on minimum quality standards with collective reputations are different from previous work that does not consider collective reputations or allows for firm traceability. Bockstael concludes that minimum quality standards cannot increase social welfare nor do they increase producer returns. She argues that minimum quality standards can be a way to limit the quantity of a good, thereby giving rents to firms in the industry.

Trigger Strategies

If minimum quality standards are not politically feasible, then another possible way of increasing average quality is for the producer group to initiate trigger strategies. Trigger strategies are a way for firms to threaten other firms if they deviate, or defect, from some optimal path. Trigger strategies can be used in the same manner as in resource extraction problems (Cave). The threat in this case is producing a lower quality so the defecting firm will lose profits because of a lower reputation level. The optimal path in this case is the monopolistic or cooperative path.

Let T^C be denoted as the cheating phase, the length of time between the initial defection and punishment. In the same manner that minimum quality standards restrict $q_t \geq q_{mt}$, firms could also use a similar threshold by replacing quality with reputation, to enter a punishment phase. If the collective reputation falls below the optimal cooperative quality level, this would trigger the other firms to revert to a noncooperative quality level.

Suppose the length of the punishment phase is denoted by T^{P}. Without loss of generality, we will assume that firms are initially operating at the optimal equilibrium level for a monopoly. Therefore, if firms cheat, they are deviating from q_m. Profit for the cheating firm is given by

$$(9)\quad \int_0^{T^{\mathrm{C}}} \mathrm{e}^{-rt}\,[p(R) - c(q_c)]\,dt + \int_{T^{\mathrm{C}}}^{T^{\mathrm{C}}+T^{\mathrm{P}}} \mathrm{e}^{-rt}\,[p(R) - c(q_p)]\,dt + \int_{T^{\mathrm{C}}+T^{\mathrm{P}}}^{\infty} \mathrm{e}^{-rt}\,[p(R) - c(q_{\mathrm{m}})]\,dt$$

subject to

$$(10)\quad \dot{R} = \gamma\left(\left(\frac{N-1}{N}\right)q_{-i} + \frac{1}{N}q_i - R\right)$$

$$R(0) = q_{\mathrm{m}}^* > 0$$

where q_i represents the quality of firm i, and is q_{c} the quality of firm during the cheating phase, q_{p} during the punishment phase, and q_{m} after the punishment phase. q_{-i} represents the quality of the noncheating firms.

During the cheating phase, firms are not identical. The cheating firm can take the other firm's quality as a constant, namely $q_{-i} = q_m$. Therefore, the first-order conditions are

$$(11a)\quad c'(q_i) = \frac{\lambda_i\gamma}{N}$$

$$(11b)\quad \dot{\lambda} = -p'(R) + \lambda_i\,[\gamma + r]$$

$$(11c)\quad \dot{R} = \gamma\left(\frac{q_i}{N} + \left(\frac{N-1}{N}\right)q_{\mathrm{m}} - R\right)$$

and the cheating firm will be moving toward an equilibrium, where

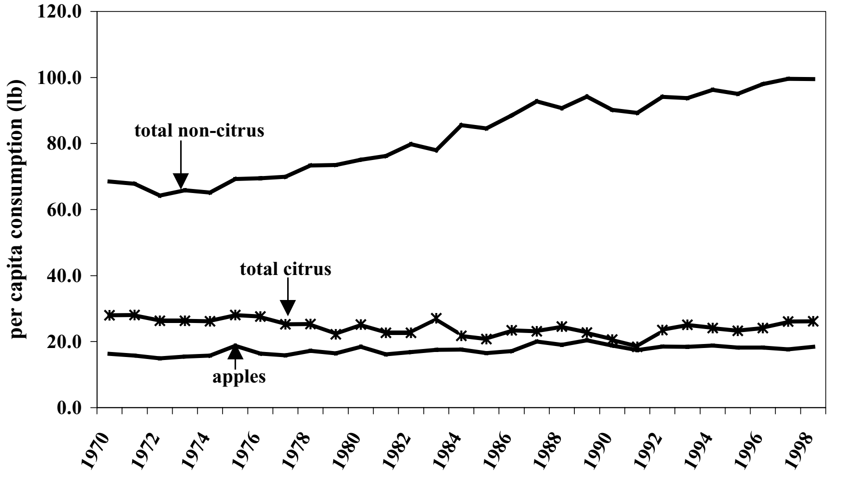
$$(12)\quad p'\left(\frac{q_i}{N} + \left(\frac{N-1}{N}\right)q_m\right) = \frac{N(\gamma + r)c'(q)}{\gamma}.$$

This implies a lower reputation level than the cooperative path.

During the punishment phase, the noncheating firms may choose to produce the noncooperative equilibrium quality level. Although the noncheating firms may choose alternative quality levels, this strategy may sufficiently punish the cheating firm. Once the punishment phase is completed, the firms may again enter a cooperative phase. This strategy makes the cooperative path a Nash equilibrium if

$$(13)\quad \int_0^{T^{\mathrm{C}}} \mathrm{e}^{-rt}\,[p(R) - c(q_c)]\,dt + \int_{T^{\mathrm{C}}}^{T^{\mathrm{C}}+T^{\mathrm{P}}} \mathrm{e}^{-rt}\,[p(R) - c(q_p)]\,dt + \int_{T^{\mathrm{C}}+T^{\mathrm{P}}}^{\infty} \mathrm{e}^{-rt}\,[p(R) - c(q_m)]\,dt < \int_0^{\infty} \mathrm{e}^{-rt}\,[p(R) - c(q_{\mathrm{m}})]\,dt.$$

If this inequality holds, it will be not profitable to cheat. One can think of the producer group that is employing trigger strategies as analogous to a "quality cartel." Instead of cheating by producing too much output, a firm can cheat by producing low quality. The major difference is that a quality war can have lingering effects on reputation (and thus also price) as opposed to a price (or quantity) war that has no lagged effects. The choice



Source: USDA/Economic Research Service.

Figure 2. Per capita consumption of fresh fruit (retail weight)

of quality in the punishment phase will affect the price in the postpunishment phase. For a punishment to be credible, the punishing firm must not want to deviate from the punishment if that part of the game is reached. The lingering effects of past quality on reputation must be considered when evaluating if a punishment is credible.

With a trigger strategy, sustainability of high quality may be achieved without minimum quality standards. Further, it may be easier for firms to threaten to engage in a quality war (for a period of time) than to continually verify minimum quality standards.

The Case of Washington Apples

The State of Washington 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. One would expect this to have a negative effect on the reputation of Washington apples and consequently on demand. We discuss the case of Washington apples in light of the results of the analytical model. We argue that individual producers' incentives for quality are not aligned with the collective group and discuss findings of declining reputation. The situation in the Washington apple industry is likely be similar to that of many other agricultural industries.

The Washington apple industry is going through difficult times. The market price for apples has been low since the mid-1990s, and per unit returns to growers is below cost of production. The world famous Red Delicious variety commands the lowest prices, even though it is the most widely produced and celebrated apple in the northwest. Per capita consumption of apples has been flat (figure 2). There is concern in the Washington apple industry that domestic consumption has gone flat because of diminished quality in terms of taste and texture. The grading system for apples rewards producers for color, shape, and size only. Eating experience has been mostly left out of the equation. Appearance matters because consumers rely on it to pick which fruit to purchase. However, appearance is only a signal of quality, it does not make the fruit taste better.

Eating quality of apples depends on many factors including brix, acid, firmness, juiciness, flavor, and texture. Eating quality for apples can be tested with technologies that use nondestructive methods. For example, the level of soluble solids can be tested with a near infrared sorter, and firmness can be tested using an acoustic firmness sensor.

When the eating experience does not meet with expectations, consumers are less likely to buy those apples again. After a bad eating experience, consumers will likely eat fewer apples, change varieties, or switch to other types of fruits. Consistency in quality is important because consumers want to be confident of the same eating experience each time they buy apples. In sum, if a subset of producers are selling bad apples, it hurts all growers.

The "Washington Apple" sticker only signals origin; it does not reflect specific quality or production standards. Some Washington apple producers use their own logos in addition to the "Washington Apple" logo to differentiate their apples. In addition, many large packing houses, such as Stemilt Growers, put their own stickers on their apples. However, the smaller producers, who do not attempt to differentiate their product, still have the economic incentive to cut costs by selling lower-quality products, while still benefiting from the collective reputation that Washington has built up over time.

If a trigger-strategy approach were applied to maintain or increase the collective reputation of Washington apples, in the nonpunishment period firms would provide high-quality and could include an origin sticker that also represents eating quality standards. During a punishment period, they would revert to the noncooperative path and not use the sticker. A concern with applying the trigger strategy to Washington apple producers is that there are so many producers, it may not work well. Recall the earlier discussion that the trigger strategy approach is analogous to sustaining a "quality cartel." It is well documented that when there are many firms in an industry, it is difficult to sustain a cartel (Carlton and Perloff). It may be that for big groups, minimum quality standards are better.

Quagrainie, McCluskey, and Loureiro's empirical study of the reputation of Washington apples precedes and motivates this article. They used monthly regional market data in order to recover the latent variable reputation. The data were compiled from cross-sectional daily observations from a number of cities, spanning four years, from July 1996 to November 1999. QML found that Washington apples have a positive but declining reputation. Our theoretical model provides an analytical explanation for QMLs empirical results. There are many growers in the State of Washington, and one would expect for growers to profit maximize by free riding on the positive collective reputation of Washington apples.

Another aspect of misaligned incentives is the sale of old apples, last year's crop, in the fresh market. Apples stored (even in controlled atmospheres) for periods greater than nine months can be negatively affected in terms acid loss, sugar development, and loss of crispness or firmness (Fellman). Collectively, apple growers in Washington should want to ban the sales of last year's crop to consumers who believe they are buying fresh apples. The apple industry lobbied the state legislature to pass a law that generally prohibited the sale of the previous year's crop after October 1 (Ashton). Growers could still sell their old fruit to juicers and canners but at a much lower price compared to the fresh market. Evans Fruit Company, a Yakima, Washington packing house, sued the Washington state Department of Agriculture, contending that the law was unconstitutional. In September 2002, Yakima County (Washington) Superior Court Judge Susan Hahn granted Evans' request (Ashton). This example illustrates how individual growers have the incentive to sell their last year's crop as fresh, while the industry as a whole would be better off if the old fruit were banned from the fresh market.

In order to maintain and build on its past good reputation, the apple industry in Washington should consider establishing minimum standards for what constitutes "eating quality" in addition to the normal grading of color, shape, and size. This suggests that reputation should be considered in any cost-benefit analysis for the industry. Loureiro and McCluskey found that if the protected geographical indications (PGI) 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" PGI label requires producers to be located in the region and also meet very strict quality and production practice standards. Indeed, the organization formerly known as the Washington Apple Commission has proposed to create standards for a new elite apple with standards for firmness and soluble solids.

Conclusions

Firms who sell a regional or specialty product often share a common or collective reputation, which is based on the group's aggregate quality. Collective reputation should be thought of as a common property resource for the group of producers. If there is more than one firm in a producer group, they have the incentive to produce lower quality and free ride on the good group reputation. We show that when there exists a collective product reputation without firm traceability, the firms will extract too much from the stock of reputation. A firm is said to "extract" reputation from the reputation stock when it sells low-quality products at high prices given by the high past levels of quality.

The results from this work support minimum quality standards for producer groups and regional and specialty products. This is in contrast to the findings of previous work that does not incorporate collective reputation.

We discussed the situation of the Washington apple industry, which does not currently have "eating quality" standards. Further, we discussed a recent court case in the State of Washington, which challenged a requirement that only fruit that has stored for less than one year can be sold in the fresh market. This case is an example of the divergence between individual growers' incentives versus industry as a whole.

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