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## The Incentive Properties of Collective Reputation

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# The Incentive Properties of Collective Reputation

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PRELIMINARY AND INCOMPLETE

## Abstract

We build a model of collective reputation under moral hazard and analyze the incentive effects of different collective reputation structures. Heterogeneous producers need to exert effort to produce high quality. The demand side a priori does not observe the true quality, however high quality is detected as such by the market with some probability, reflecting e.g. expert inspections and awards. Products not detected as of high quality are pooled together according to the collective reputation structure, i.e. grouping of producers. In the unique equilibrium, each group is subject to internal free-riding by their higher-cost members. We find that full collective reputation can yield higher quality and welfare than individual reputation, since inter-producer free-riding under full collective reputation might be less severe than intra-producer free-riding under individual reputations. However, full collective reputation is never optimal: A cut-off collective reputation structure with a small elite improves upon full collective reputation. Despite potentially higher producers' surplus (and welfare) under some collective reputation, any group with collective reputation unravels in absence of transfers. Nevertheless, we show that simple non-type-dependent internal contracts under collective reputation implement the First Best.

*JEL classification:* D82; D47; D71; L15.

**Keywords:** Collective Reputation, Quality, Incentives.

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# 1 Introduction

Collective reputation is an important institution for the functioning of many markets otherwise plagued by asymmetric information about product quality. It is quite common in manufacturing industries - think about Swiss watches, Italian clothing, German cars - where country of origin may be evocative of the average quality of products. It may be an important institution for service sectors as well, for instance in educational systems, where reputational concerns have affected the choices of students, families, and school administrators (see, e.g., [Drori et al., 2015](#)), and it has been long recognized that graduates use their school of origin to signal ability, endogenously leading to stratification ([MacLeod and Urquiola, 2015](#)). In agricultural markets collective reputations have been intensely supported and regulated as well, like for instance for many European cheeses (e.g., Camembert, Comté) and wines (e.g., Champagne, Bordeaux, Chianti), just to name a few examples.

In this paper we develop a new model of collective reputation under moral hazard and adverse selection to investigate the incentives faced by firms in providing quality under alternative collective reputation structures. We consider a continuum of heterogeneous firms which need to exert effort to produce quality and differ in their cost. The demand side a priori does not observe the true quality; however, high quality is detected as such by the market with some probability through a given technology, reflecting for instance the performing of inspections, the provision of experts' advice, the winning of awards, and the like. Products not detected as of high quality are pooled together according to the collective reputation structure, i.e., grouping or partitioning of producers. Thus our model of collective reputation focuses on 'friendly' informational environment, in the sense of [Fleckinger et al. \(2017\)](#), while [Tirole \(1996\)](#) classic analysis of persisting corrupt reputation relies on a 'hostile' informational environment.

In our setting, any collective reputation structure yield a unique equilibrium. It is characterized by a cutoff cost-type in each group, such that only members with costs below the threshold provide high quality, while the others free-ride. Still, we find that full collective reputation can yield higher quality and welfare than individual reputation, since inter-producer

free-riding under full collective reputation might be less severe than intra-producer free-riding under individual reputations.

We also compare different collective reputation structure from an economic welfare point of view, and investigate whether it is possible to design a stable collective reputation system. We show that full collective reputation is never optimal: indeed, there exists a cut-off such that a collective reputation structure with a small elite improves upon full collective reputation. In other words, a well chosen grouping of producers may increase welfare. However, despite producers' surplus (and welfare) being potentially higher under collective reputation, this is not the case at the individual level: lowest cost producers in a group would always prefer to split and adopt individual reputations, so that any group with collective reputation without transfers or mandatory participation will tend to unravel. Type-dependent transfers can naturally make a collective reputation structure stable, but we show that simple non-type-dependent internal transfers under collective reputation can not only satisfy stability, but even implement the first best.

While our model is general, we discuss it extensively in the context of the wine sector, an unsurpassed example for issues discussed both at the industry and policy-making levels. We show for instance how collective reputation may increase the overall incentives for quality investments, thus explaining why some policy-makers are giving them such an important role. In the EU, for instance, Geographical Indications (GIs) are becoming so important that at some point they constituted a major obstacle in the TTIP trade agreements with the US (see, e.g., [Breteau and Audureau, 2016](#)).<sup>1</sup> Given that international trade is increasingly based on quality competition (see, e.g., [Baldwin and Harrigan, 2011](#); [Crozet et al., 2012](#)), this seems an understandable concern.

Moreover, our model can be used to design the optimal collective reputation structure in order to best group producers. If a group splits, incentives for low-cost producers may

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<sup>1</sup>Collective reputations were probably first officially recognized and regulated in Europe, but have been (and still are) spreading all over. In the USA, American Viticultural Areas regulation has been in use since 1978 (Napa Valley was recognized in 1981). New Zealand has decided to bring into force the so called "GI Act" with a registration regulation, to establish a system for acknowledging and registering Geographical Indications (GIs) from abroad and from NZ. More recently, China's emerging Ningxia wine region has announced plans for its first winery classification based on a Bordeaux-like system ([Wu, 2016](#)).

decrease, while those for high-cost producers increase to the extent that free-riding is reduced. We show that there exists an optimal cutoff such that welfare is greater with two subgroups. This implies that information may be finer at the top, i.e., leading to vertical collective reputations and elitism. This is perfectly illustrated by the system in Bourgogne, which has a hierarchical classification where all ‘climats’ are identified and those at the top more finely defined.<sup>2</sup> However, while splitting into finer partitions may be sometimes good for quality incentives and economic welfare, not any splitting is welfare-improving: a badly chosen cutoff, can in fact destroy value.

While we argue that in some circumstances collective reputation may be welfare increasing, the lowest cost producers in any group producing quality would always prefer to secede. This implies that if participation is voluntary, we should expect unraveling from the top, i.e., reputation unraveling. The attempts of top producers to leave collective reputations have been duly reported, for instance, for Rioja wines in Spain (Mount, 2016), Amarone wines in Italy (Guerrini, 2013), Loire wines in France (Anson, 2013), and for milk in the US Milk Marketing Order (Crespi and Marette, 2002), just to name a few.

In the last part of the paper we thus investigate how one can sustain collective reputations, by considering internal transfer systems across producers and/or mandatory participation. We show that non type-dependent transfer schemes can be designed to make a group stable, and we suggest such two simple implementations, one based on an entry fee and a bonus subsidy, and the other based on ex-post taxation based only on market prices. After briefly referring to related literature, in the next section we introduce the model. We then investigate quality incentives and economic welfare of collective and individual reputations, highlighting under which circumstances collective reputation may improve upon individual ones. We then perform a positive analysis, to investigate how one can design a stable collective reputation system. We finally conclude with a discussion of possible extensions and directions for further work.

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<sup>2</sup>An interesting case matching our predictions is Montagny, a village in Bourgogne that has recently opted for a more ‘elitist’ collective structure (Anson, 2016).

## Related literature

While the contributions on individual reputation are very numerous (for a survey see, e.g., [Bar-Isaac and Tadelis, 2008](#)), those on collective reputation are more limited (though increasing). Collective reputation is associated with various ideas (and models) in the literature. The seminal paper on collective reputation by [Tirole \(1996\)](#) builds on the classic game theoretic approach to reputation (e.g. [Kreps and Wilson, 1982](#)), where agents can be of different types. [Tirole \(1996\)](#) and [Levin \(2009\)](#) study dynamic situations, and are interested in the interplay between individual and collective reputation, as well as in the circumstances where high quality equilibria can be sustained (or not).

[Tirole \(1996\)](#) is the seminal reference, and his main result pertains to the multiplicity of equilibria that leads to potentially long-lasting low reputation equilibria. As [Fleckinger et al. \(2017\)](#) show, multiplicity is a consequence of the 'hostile' informational environment. We consider here a 'friendly' informational environment which is more realistic in some applications, like wine, but also enables unambiguous comparison between different collective reputation structure—a distinctive feature of our analysis.

In that respect, our model relates to the group design model of [Board \(2009\)](#). However, we are concerned with providing incentives for quality, while his contribution is in understanding profit-maximizing price strategy in the design of groups. Our paper also relates to the literature on status competition ([Moldovanu et al., 2007](#)) and optimal grading systems ([Dubey and Geanakoplos, 2010](#)). These papers study the optimal way of dividing players into categories, ex-ante or ex-post, to provide incentives. There, the player's payoff directly depend on the rank or status, while producers in our setup do not care about status per se, but only about the informational content provided by the grouping.

Finally, most of the applications in the literature pertains to agricultural products ([Winfree and McCluskey, 2005](#), e.g.) or service markets ([Levin and Tadelis, 2005](#)). The question of comparing the incentive effects of different collective reputation structures has so far not been studied to our knowledge.

## 2 A Model of Collective Reputation

We consider a set of heterogeneous producers,  $\mathcal{P}$ , with unit mass. Each producer  $p \in \mathcal{P}$  is characterized by a cost parameter  $\theta \in [0, 1]$  of providing quality. This characteristic pertains to production technology, individual skill and so on.  $\theta$  is distributed in the group of producers according to the continuous c.d.f.  $F(\theta)$ , which is common knowledge.

### Collective Reputation Structures.

Producers are organized into groups, which are Borel sets of  $\mathcal{P}$ . Note that this definition allows two producers with the same  $\theta$  to belong to different groups. A collective reputation structure  $\mathcal{R}$  splits the set of producers into a collection of disjoint groups indexed by  $g \in \mathcal{G}$  whose union equals  $\mathcal{P}$ . We restrict attention to a countable set of groups, and for convenience, work directly with the distributions over  $\theta$  within groups, which we further assume to be continuous. Thus, any countable collection of continuous distributions and associated weights  $\{\lambda_g, F_g\}_{g \in \mathcal{G}}$  defines an admissible reputation structure when it satisfies:

$$\sum_{g \in \mathcal{G}} \lambda_g = 1 \quad \text{and} \quad \sum_{g \in \mathcal{G}} \lambda_g F_g(\theta) = F(\theta)$$

In words,  $\lambda_g$  represents the relative weight of group  $g$  in the population of producers, and  $F_g$  is the distribution of types conditional on the producer belonging to group  $g$ . Importantly, the collective reputation structure  $\mathcal{R}$  is common knowledge but consumers only observe group membership, not the type of a producer.

Some polar collective reputation structures are worth emphasizing. We say that there is full collective reputation (FCR) if there is a single group. We say that there is a cutoff vertical collective structure (CVCR) if producers are split in two groups according to a threshold type  $\sigma$ . Furthermore, we say that the reputation structure is horizontal when producers are not grouped according to  $\theta$ .

Finally, we will also make use of a structure not covered by the previous definition but crucial in the analysis: we say that there is individual reputation (IR) if each producer is alone in

his group, or, equivalently, when  $\theta$  is observed by consumers.

### Production and information.

Quality is binary, being high or low, and  $q$  denotes the probability of obtaining high quality. We sometimes slightly abuse notation by referring to  $q = 0$  and  $q = 1$  as low and high quality, respectively. A producer with type  $\theta$  choosing  $q \in [0, 1]$  incurs a cost  $c(q, \theta) = \theta q$ .

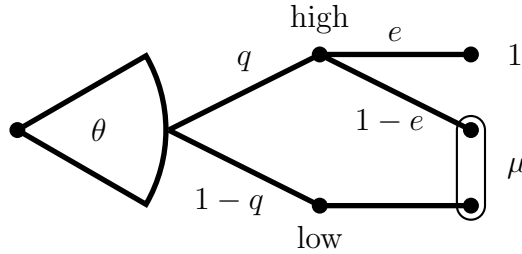


Figure 1: Information structure.

On the demand side, the willingness to pay is normalized to 1 for high quality and 0 for low quality. The demand side of the market a priori does not observe the true quality of a good from a given producer. However, in the market there are experts who provide (some) information on quality through ratings, recommendations, awards etc. We assume that high quality is publicly recognized as such with probability  $e$ , which captures the intensity of attention of experts. In case the quality is low, no public information is provided—the good can not win an award or be distinguished, however, it is also not singled out as being of low quality. Hence there are two ex-post types of goods on the market: the ones which have been identified as high quality, and the unidentified ones.<sup>3</sup> We assume that a good is traded at its expected quality, i.e. producers are able to charge fully the willingness to pay of the consumers. An identified high quality good is thus traded at a high price of  $p = 1$ , while an identified good is traded on the basis of its reputation  $\mu$ , that is, the belief that the good is of

<sup>3</sup>This informational assumption is consistent with several stories. In wine, experts inspect a fraction  $e$  of the wines, and reports those that they deem of good quality, and don't publicize bad quality. Or expert buyers such as upscale hotels and restaurants buy themselves good wines on a primary market, and then the remaining wines are sold on the general market for non-experts. Informational details actually do not matter qualitatively for our results beyond the fact that at the time of trade, there is a higher chance for a good wine to be recognized as such than for a bad wine to be recognized as such.



high quality given that it has not received a positive review from experts. The corresponding price is therefore  $p(\mu) = \mu \cdot 1 + (1 - \mu) \cdot 0 = \mu$ . Note that all products are therefore traded. For a given reputation  $\mu$ , the expected payoff of a producer is then given by:

$$\Pi(q, \theta) = q(e + (1 - e)\mu) + (1 - q)\mu - c(q, \theta). \quad (1)$$

The actual quality and reputation  $\mu$  that emerge will result from the collective reputation structure, the incentives of producers and the information structure. We adopt the notion of perfect Bayesian equilibrium where each (type of) producer chooses their best reply to the market's belief, and the non-informed buyers' beliefs are consistent with the distribution of quality offered. Observe that, since  $F(\theta)$  and the collective reputation structure  $\mathcal{R}$  are common knowledge, we can analyze each group in a collective reputation structure separately: For a given group, the market's belief for this group and therefore producer incentives are independent of collective reputation structure for all producers not belonging to the group. Since we can analyze groups separately, we will sometimes slightly abuse wording for simplicity and speak of the *group equilibrium* when characterizing equilibrium behavior in the group in the perfect Bayesian equilibrium of the market.

Welfare in the market is given by quality minus costs. Hence, for a given collective reputation structure, we have:

$$W = \sum_{g \in \mathcal{G}} \lambda_g \int_0^1 (1 - \theta) q_g(\theta) f_g(\theta) d\theta, \quad (2)$$

where  $q_g(\theta)$  is the quality chosen by a producer of quality  $\theta$  in group  $g$ . The implicit assumption that all producers with the same  $\theta$  in a group choose the same quality is without loss of generality as we shall see in the equilibrium analysis.

## 2.1 Equilibrium with Collective Reputation

Consider group  $g$  with  $F_g(\theta)$  continuous and  $F_g(e) > 0$ . Since an individual producer alone does not influence  $\mu_r$ , the profit is linear in  $q$ . Hence a producer chooses  $q = 1$  whenever  $\Pi(1, \theta) \geq \Pi(0, \theta)$ , which translates into  $\theta \leq e(1 - \mu_g)$ . An almost immediate consequence of

these incentives considerations is that in all groups equilibria have a cutoff structure: they will be characterized by a cost threshold  $\theta_g^*$  below which producers of group  $g$  choose high quality and above which producers of group  $g$  choose low quality, that is:

$$\theta_g^* = e(1 - \mu_g^*). \quad (3)$$

The unidentified goods consist of a mix of low and high quality goods, and the equilibrium reputation has to obey Bayes' rule:

$$\mu_g^* = \frac{(1 - e)F_g(\theta_g^*)}{(1 - e)F_g(\theta_g^*) + (1 - F_g(\theta_g^*))} = \frac{(1 - e)F(\theta_g^*)}{1 - eF_g(\theta_g^*)}. \quad (4)$$

We can now state the first proposition.

**Proposition 1 (Equilibrium with Collective Reputation).** *For any admissible collective reputation structure, there is a unique equilibrium, such that for all  $g$ , there exists a threshold  $\theta_g^*$  such that in group  $g$ , a producer of type  $\theta \leq \theta_g^*$  chooses  $q = 1$ , and  $q = 0$  otherwise. Average quality in group  $g$  is*

$$F_g(\theta_g^*) = \frac{e - \theta_g^*}{e(1 - \theta_g^*)}, \quad (5)$$

*and the reputation for unidentified quality is*

$$\mu_g^* = (1 - \theta_g^*)F(\theta_g^*). \quad (6)$$

*Proof.* Consider group  $g$ . Combining equations (3) and (4), we obtain equations (5) and (6). Notice that in (5) the left-hand side is increasing in  $\theta_g^*$  while the right-hand side is decreasing in  $\theta_g^*$ , so that there exists a unique solution, possibly a corner solution with no quality at all when  $F_g(e) = 0$ .  $\square$

With this proposition, equilibrium under Full Collective Reputation follows immediately:

**Corollary 1.** *(Equilibrium with Full Collective Reputation).*

Under Full Collective Reputation (FCR), there exists a unique equilibrium, such that a producer with  $\theta \leq \theta^*$  chooses  $q = 1$ , and  $q = 0$  otherwise. Average quality is  $F(\theta^*) = \frac{e - \theta^*}{e(1 - \theta^*)}$  and the reputation for unidentified quality is  $\mu^* = (1 - \theta^*)F(\theta^*)$ .

Welfare in equilibrium under FCR is easily computed as:

$$\begin{aligned} W_{Fcoll}(e) &= \int_0^{\theta^*} (1 - \theta)f(\theta)d\theta \\ &= (1 - \theta^*)F(\theta^*) + \int_0^{\theta^*} F(\theta)d\theta \\ &= \mu^* + \int_0^{\theta^*} F(\theta)d\theta \end{aligned}$$

and individual payoff in the FCR equilibrium is given by:

$$U_{Fcoll}(\theta) = \begin{cases} e + (1 - e)\mu^* - \theta & \theta \leq \theta^* \\ \mu^* & \theta > \theta^*. \end{cases}$$

To derive the incentive effects from collective reputation in a group, the following comparative statics results are helpful.

**Proposition 2 (Comparative Statics for a Group with Collective Reputation).**

Consider group  $g$  with  $F_g(\theta)$ . The comparative statics in  $e$  is:

- $\theta_g^*$  and  $F_g(\theta_g^*)$  increase in  $e$ : more information increases incentives and average quality.
- $\mu_g^*$  is increasing for  $e$  close to 0, and decreasing for  $e$  close to 1.
- if  $F_g$  is log-concave,  $\mu_g^*$  is single-peaked in  $e$ : reputation is first-increasing, then decreasing when more information becomes available.

Consider first-order stochastic decreases of  $F_g$  (i.e. stochastically lower costs):

- $F_g(\theta_g^*)$  increases when  $F_g$  decreases: quality increases when costs decrease.

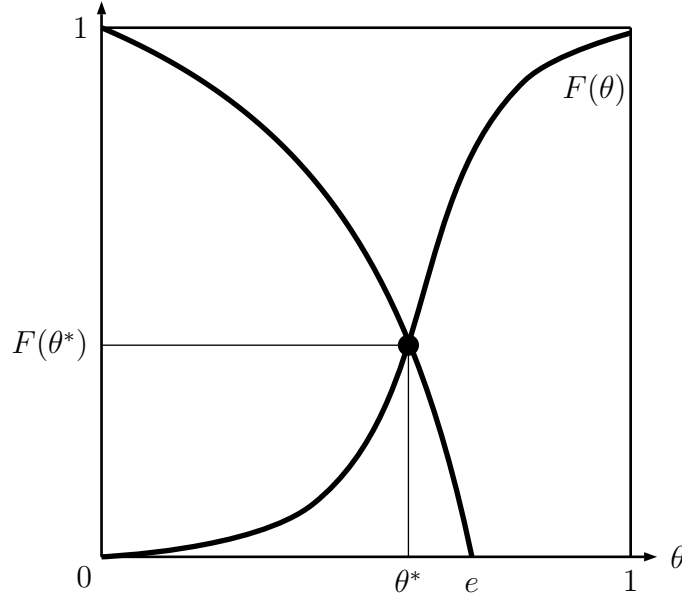


Figure 2: Equilibrium in the  $(\theta, F(\theta))$  space under FCR.

- $\mu_g^*$  increases when  $F_g$  decreases: reputation increases when costs decrease.
- $\theta_g^*$  decreases when  $F_g$  decreases: incentives in equilibrium decrease when costs decrease.

*Proof.* We suppress the index  $g$  for notational clarity. The first bullet is obtained by differentiating (5) with respect to  $e$ , which yields:  $\frac{\partial \theta^*}{\partial e} = \frac{1 - (1 - \theta^*)F(\theta^*)}{1 - F(\theta^*) + (1 - \theta^*)f(\theta^*)}$ . For the second bullet, differentiating (6) with respect to  $e$  yields  $\frac{\partial \mu^*}{\partial e} = [-F(\theta^*) + (1 - \theta^*)f(\theta^*)] \frac{\partial \theta^*}{\partial e}$ , so that the two limit cases yield  $\frac{\partial \mu^*}{\partial e}|_{e=0} = f(0)$ ,  $\frac{\partial \theta^*}{\partial e}|_{e=0} \geq 0$  and  $\frac{\partial \mu^*}{\partial e}|_{e=1} = -\frac{\partial \theta^*}{\partial e}|_{e=1} \leq 0$ . For the third bullet,  $F$  log-concave says  $f/F$  is decreasing. This implies that there is a threshold  $\theta$  below which  $[-F(\theta) + (1 - \theta)f(\theta)] = \frac{F(\theta)}{(1 - \theta)} \left[ \frac{f(\theta)}{F(\theta)} - \frac{1}{(1 - \theta)} \right]$  is positive and above which it becomes negative, because the functions  $f/F$  and  $1/(1 - \theta)$  are respectively decreasing and increasing, and cross on the interval  $[0, 1]$ . Since  $\frac{\partial \theta^*}{\partial e} > 0$ , this allows to conclude.

The fourth and sixth bullet comes directly from inspection of (5) and (6), see [Fleckinger et al. \(2017\)](#). The fifth bullet comes from combining (4) with the fourth bullet.  $\square$

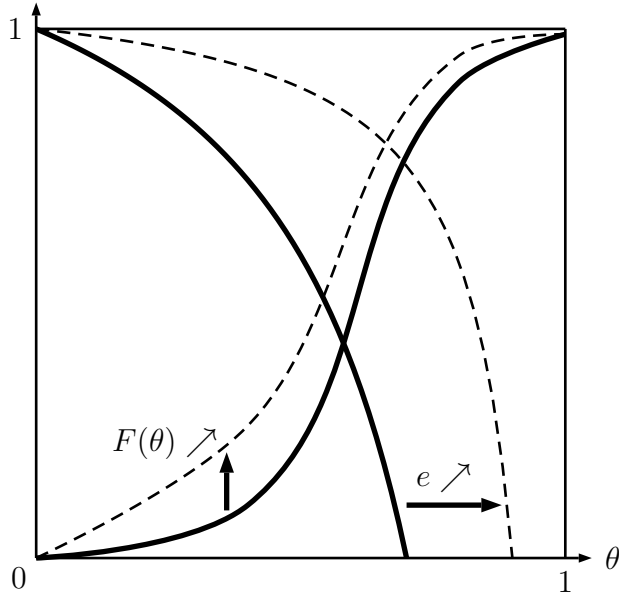


Figure 3: Comparative statics.

### Incentives under Collective Reputation

From the above analysis, we can take a closer look at the implications of collective reputation on incentives within groups. First, observe that if a group produces quality, high cost producers of the group (above  $\theta_g^*$ ) free-ride on the quality of low cost producers in the group. Notice that everybody would like to kick out the other high cost producers (those above  $\theta_g^*$ ), since everybody wants a higher reputation  $\mu_g^*$ . However, kicking out the high cost producers would in turn lower incentives in the remaining group (decrease in  $\theta_g^*$ ). Moreover, if low cost producers (below  $\theta_g^*$ ) separated, incentives of the others would increase. From the comparative statics in  $e$  we also have that all types of producers like information to some extent: those who choose  $q = 1$  because this increases their chances of recognition, those who chose  $q = 0$  because it increases  $\mu_g^*$  up to some point. In the following, we will turn to the analysis of individual reputation to contrast the incentive structures under individual and collective reputation.

## 2.2 Equilibrium under Individual Reputations

Individual reputation, where each producer is alone in his group, implies that each producer's  $\theta$  is known by the market. In that case, reputation is individual in the sense that the belief about quality in case no news is revealed depends only on the type  $\theta$  producer's equilibrium action, and not on that of a group of producers. It is easy to see that mixing will be involved, i.e.  $q \in (0, 1)$ : producing quality with probability 1 cannot happen if the cost is positive. Indeed, if it were the case, then in equilibrium the market would attribute the best reputation to such a producer, but that would in turn kill incentives. Hence high quality cannot be produced for sure (unless the cost is exactly 0). Moreover, if the cost is too high, the producer will never produce high quality. The next proposition characterizes the equilibrium.

**Proposition 3** (Equilibrium with Individual Reputation). *There exists a unique equilibrium, such that a producer of type  $\theta$  produces high quality with probability*

$$q^*(\theta) = \text{Max}\left\{\frac{e - \theta}{e(1 - \theta)}, 0\right\}, \quad (7)$$

*and the reputation of a producer of type  $\theta$  is*

$$\mu^*(\theta) = (1 - \theta)q^*(\theta). \quad (8)$$

*Proof.* For a producer with type  $\theta$ , the payoff in case of no news depends on a belief  $\mu(\theta)$  specific to that type of producer. When the producer chooses a strategy  $q(\theta) \in [0, 1]$ , the corresponding reputation is  $\mu(\theta) = \frac{(1-e)q(\theta)}{1-eq(\theta)}$  by applying Bayes' rule. For the producer to rationally choose this strategy, it must be that given  $\mu(\theta)$ , the first-order condition holds. Since  $\Pi$  is linear in  $q$ , this is akin to the indifference property in mixed strategy equilibria, i.e. indifference between choosing  $q = 1$  and  $q = 0$ , which entails  $\mu(\theta) = 1 - \frac{\theta}{e}$ . Combining this with the Bayesian revision yields the two equations.  $\square$

In that configuration, welfare is given by  $W_{Ind} = \int_0^1 q^*(\theta)(1 - \theta)f(\theta)d\theta$ . Replacing  $q^*(\theta)$ ,

then integrating by parts and rearranging yields:

$$W_{Ind} = \frac{1}{e} \int_0^e F(\theta) d\theta \quad (9)$$

### 3 Collective Reputation and Welfare

In section 2.1, we have seen that collective reputation has interesting incentives effects: Reducing the size of a group by excluding high cost members increases reputation, but reduces incentives. Reducing the size of a group by excluding low cost members conversely reduces reputation, but increases incentives. The implications for overall quality and welfare in different collective reputation structures are not straightforward. To highlight the tradeoffs inherent in different collective reputation structures, we will first start by comparing the two extreme structures, full collective reputation and individual reputations.

#### 3.1 Can Full Collective Reputation Fare Better than Individual Reputations?

Under FCR, the group's reputation leads to inter-producer free-riding, which contrasts to the intra-producer free-riding under IR. In particular, under FCR producers of type  $\theta > \theta^*$  choose low quality with probability one, while under IR types  $\theta$  with  $\theta^* < \theta < e$  choose  $q > 0$ . However, Under FCR, low cost producers ( $\theta \leq \theta^*$ ) provide high quality with probability one, which is different from low cost producers under IR, where only type 0 producers provide high quality with probability one, while for all others,  $q < 1$ . Thus, we observe that under IR compared to CR, effort is shifted from relatively more efficient to relatively less efficient producers. In fact, for a *given* level of quality in the market, welfare under FCR is always higher than under IR because of a more efficient effort allocation under FCR.

Comparison of quality however depends in more detail on the properties of the type distribution. In the case of the uniform distribution, one can easily compare welfare under collective

and individual reputation:

$$\begin{aligned}
W_{coll} - W_{ind} &= (1 - \theta^*)F(\theta^*) + \int_0^{\theta^*} F(\theta)d\theta - \frac{1}{e} \int_0^e F(\theta)d\theta \\
&= (1 - \theta^*)\theta^* + \int_0^{\theta^*} \theta d\theta - \frac{1}{e} \int_0^e \theta d\theta \\
&= (1 - \theta^*)\theta^* + \frac{(\theta^*)^2}{2} - \frac{e}{2} \\
&= \frac{1}{2}\theta^*(1 - \theta^*)(1 - e),
\end{aligned}$$

where we used (5) to obtain that  $e\theta^*(1 - \theta^*) = e - \theta^*$ . Hence we proved the following proposition.

**Proposition 4.** *Suppose that  $F$  is the uniform distribution on the unit interval. Then Collective Reputation yields higher welfare than Individual Reputation.*

Thus, for the case of the uniform distribution, individual reputations perform worse than full collective reputation. *Figure 4* shows equilibrium qualities in both structures and highlights the quality and cost trade-off between both structures: More quality from more efficient types under FCR, versus quality from a larger set of types (with more inefficient types) under IR. From inspecting *Figure 4*, it also becomes apparent that *Proposition 4* does not generalize to arbitrary distributions. For the general case:

$$W_{coll} - W_{ind} = (1 - \theta^*)F(\theta^*) + \int_0^{\theta^*} F(\theta)d\theta - \frac{1}{e} \int_0^e F(\theta)d\theta$$

Since FCR can perform better than IR, an obvious question is whether, for a given class of distributions, might be optimal. This question will be addressed in the next section.

### 3.2 Can Full Collective Reputation Be Optimal?

Under FCR, all producers are pooled together. However, from the discussion of incentives in *Section 2.1*, splitting producers into well-chosen groups might be a good idea. We start by considering a grouping of producers into two distinct groups where a cost cutoff  $\sigma < e$



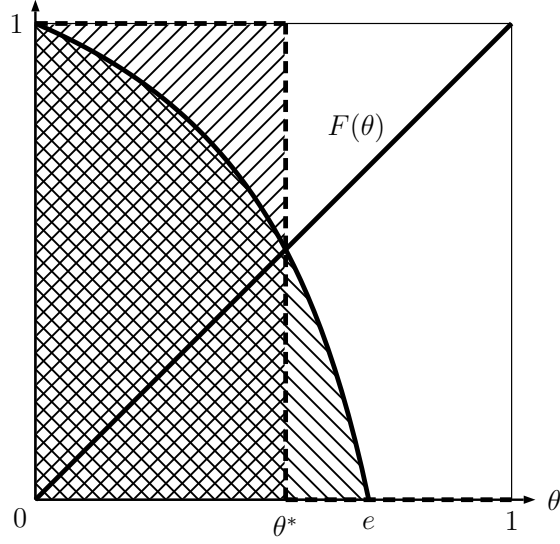


Figure 4: Quality provision FCR vs IR.

separates the two groups. In such case, the two groups have corresponding distributions  $F_1$  and  $F_2$ , where 1 corresponds to the set of producers with  $\theta \leq \sigma$ . These truncated distributions are thus:

$$F_1(\theta) = \min\left\{\frac{F(\theta)}{F(\sigma)}, 1\right\} \quad \text{and} \quad F_2(\theta) = \max\left\{\frac{F(\theta) - F(\sigma)}{1 - F(\sigma)}, 0\right\}$$

Equipped with these cumulative distributions, one can directly apply the equilibrium characterization results obtained in [Section 2.1](#).

**Lemma 1** (Cost distributions with a cutoff). *For any  $\sigma$ ,  $F_2$  first-order stochastically dominates  $F$  which first-order stochastically dominates  $F_1$ .*

*For  $i = 1, 2$ , for any cutoffs  $\sigma$  and  $\sigma'$  with  $0 < \sigma < \sigma' < 1$  and associated distributions  $F_i$  and  $F'_i$ ,  $F'_i$  first-order stochastically dominates  $F_i$ : an increase in  $\sigma$  stochastically increase costs in **both** groups.*

*Proof.* The first part is obvious given the formulas of truncated distributions. The second part follows simply from differentiating these formulas with respect to  $\sigma$ .  $\square$

Though rather obvious, this lemma has several important implications when combined with the equilibrium comparative statics obtained before. Average qualities are ordered intu-

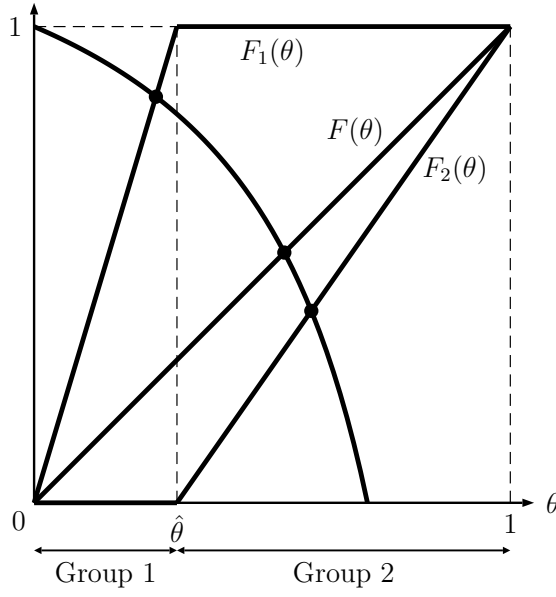


Figure 5: Two groups (uniform distribution and cutoff split).

itively:  $F_1(\theta_1^*) > F(\theta^*) > F_2(\theta_2^*)$ , but incentives are lower in the first group:  $\theta_1^* < \theta^* < \theta_2^*$ . Since reputation increases in group 1 compared to the case of a single group (recall that reputation  $\mu_g^*$  always increases in average quality  $F_g(\theta_g^*)$ ), incentives are reduced from equation (3). Hence, splitting the producers increases incentives for high cost producers at the costs of decreasing those for low cost producers. Thus, it is not straightforward whether one or the other solution is associated with more total quality (aggregated over the two groups). Moreover, allocation of effort across producers with two groups is not optimal: between  $\theta_1^*$  and  $\sigma$ , there is no effort, while producers between  $\sigma$  and  $\theta_2^*$  again exert effort.

**Proposition 5.** *There exists a cutoff  $\sigma > 0$  such that welfare with two groups separated at  $\sigma$  is higher than welfare with Full Collective Reputation.*

*Proof.* Welfare with cutoff  $\sigma$  is

$$W(\sigma) = \int_0^{\theta_1^*(\sigma)} (1 - \theta) f(\theta) d\theta + \int_{\sigma}^{\theta_2^*(\sigma)} (1 - \theta) f(\theta) d\theta$$

Note that  $W(0) = W(1) = W_{coll}$ . The derivative of welfare with respect to  $\sigma$  is

$$\frac{dW}{d\sigma} = (1 - \theta_1^*(\sigma))f(\theta_1^*(\sigma))\frac{d\theta_1^*}{d\sigma} + (1 - \theta_2^*(\sigma))f(\theta_2^*(\sigma))\frac{d\theta_2^*}{d\sigma} - (1 - \sigma)f(\sigma).$$

We hence have

$$\left.\frac{dW}{d\sigma}\right|_{\sigma=0} = f(0)\left(\left.\frac{d\theta_1^*}{d\sigma}\right|_{\sigma=0} - 1\right) + (1 - \theta_2^*(0))f(\theta_2^*(0))\left.\frac{d\theta_2^*}{d\sigma}\right|_{\sigma=0}.$$

Applying proposition 1 to the truncated distributions, we obtain by differentiating (5) with respect to  $\sigma$  in both groups:

$$\frac{d\theta_1^*}{d\sigma} = \frac{(e - \theta_1^*)f(\sigma)}{F(\sigma) - eF(\theta_1^*) + e(1 - \theta_1^*)f(\theta_1^*)}$$

and

$$\frac{d\theta_2^*}{d\sigma} = \frac{(1 - e)\theta_2^*f(\sigma)}{1 - (1 - e)F(\sigma) + e(1 - \theta_2^*)f(\theta_2^*) - eF(\theta_2^*)}.$$

Hence, since  $f > 0$ , we have

$$\left.\frac{d\theta_2^*}{d\sigma}\right|_{\sigma=0} = \frac{(1 - e)\theta_2^*f(0)}{1 + e(1 - \theta_2^*)f(\theta_2^*) - eF(\theta_2^*)} > 0,$$

such that the second term in the welfare derivative is positive. Moreover, since when  $\sigma = 0$  we have  $\theta_1^* = 0$ ,  $\left.\frac{d\theta_1^*}{d\sigma}\right|_{\sigma=0} = \frac{ef(0)}{ef(0)} = 1$  so that the first term in the welfare is zero. In total, we thus have  $\left.\frac{dW}{d\sigma}\right|_{\sigma=0} > 0$ , so that there exists an interior cutoff  $\sigma$  strictly improving on the single group.  $\square$

Thus, independent of the type distribution, FCR is never optimal.<sup>4</sup> Note that a cutoff  $\sigma$  with  $e \leq \sigma < 1$  always yields lower welfare than FCR: For  $\sigma = e$ , there is no effort in group 2, and since  $\theta_1^* < \theta^*$ ,  $F(\theta_1^*) < F(\theta^*)$  such that quality is lower with a cutoff  $\sigma = e$  than under full reputation. Since it is efficient for all  $\theta$  with  $\theta_1^* \leq \theta \leq \theta^*$  to exert effort, welfare with a cutoff  $\sigma = e$  is lower than welfare under full reputation. Now note that welfare is

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<sup>4</sup>In the proof of *Proposition 5*, we use that there is no incentive problem with the lowest cost type.

increasing in  $\sigma$  for  $\sigma \geq e$  for the following reasoning:  $\theta_1^*$  is increasing in  $\sigma$ , and there is no change in group 2. Hence, average quality is increasing in  $\sigma$  for  $\sigma \geq e$  with only the most efficient producers increasing effort such that welfare increases.

The result from this section show that going from Full Collective Reputation to an organization of producers that splits producers into two groups by a cutoff increases welfare. The logic behind it is that (1) the free-riding in the high-cost group is reduced such that quality in this group is increased by more than it is reduced in the other group (higher free-riding among low-cost producers), and (2) the potential inefficiency from more inefficient types exerting effort is not large.

## 4 Sustainability of Collective Reputation

### 4.1 Reputation Unravelling

In the previous section, it was shown that welfare and payoffs for a producer organization that features some form of collective reputation—or even full collective reputation— can be higher than under individual reputations. However, this does not imply that individual producers would prefer to stay in a group rather than work under their individual reputations. In fact, individual incentives are such that the lowest cost producers in any group producing quality would always prefer to split from the group such that collective reputation would unravel, which we show in the next proposition.

**Proposition 6.** *In a collective reputation structure, any group producing quality unravels to individual reputation if there are no transfers between group members.*

*Proof.* For any collective reputation structure, consider the lowest cost type  $\underline{\theta}_i$  in some group  $i$  that produces quality. The payoff of this type is  $U_{ind}(\underline{\theta}_i) = \mu(\underline{\theta}_i) = 1 - \frac{\underline{\theta}_i}{e}$  under individual reputation and  $U_{coll}(\underline{\theta}_i) = \mu_i^* + \theta_i^* - \underline{\theta}_i = 1 - \frac{\theta_i^*}{e} + \theta_i^* - \underline{\theta}_i$  under collective reputation. We have  $U_{ind}(\underline{\theta}_i) - U_{coll}(\underline{\theta}_i) = (\theta_i^* - \underline{\theta}_i)(\frac{1}{e} - 1) > 0$ .  $\square$

The problem underlying the result—that the lowest cost producers in any group producing quality always have a higher payoff under individual reputations—is illustrated below in *Figure 5* for FCR with the uniform distribution.<sup>5</sup> Note that, contrary to unraveling with pure Adverse Selection, which is efficient, unraveling here with Moral Hazard can be inefficient.

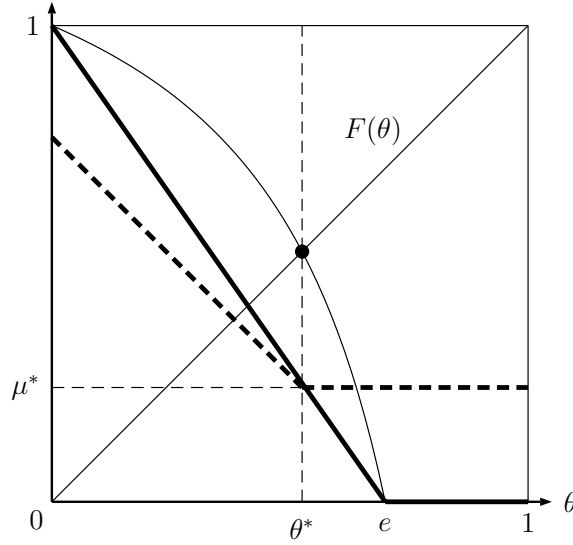


Figure 6: Individual payoff under collective and individual reputation ( $e=0.7$ , uniform distribution—a case in which FCR is better).

Thus, the question is whether a group can implement an internal incentive system to sustain collective reputation in order to reap its benefits. Clearly, when types are observed within a group and transfers between group members can thus be type-dependent, if collective reputation yields higher welfare—which corresponds to producers surplus in our set-up—than individual reputations, this benefit of collective reputation can be redistributed to low cost producers to entice them to stay in the group. What we will show in the next section is that even when types are not observed within the group and transfers cannot be type-dependent, collective reputation can be sustained. Even more, a simple non-type-dependent transfer scheme can ensure participation and increase incentives of group members to the extent that First Best qualities are provided.

<sup>5</sup>This is the case in which FCR yields higher welfare (and producer surplus) than IR, see *Proposition 4*.

## 4.2 A Simple Group Incentive Scheme

When types are not observed in a group, one can easily show that the only mechanisms available have to be pooling. The only available information that can be contracted upon is the market price received. Hence a scheme has (at most) two instruments. We will consider the following group incentive scheme, without loss of generality: a participation fee  $t$  is levied on each producer and a bonus for identified high quality  $s$ . The bonus  $s$  increases incentives in the group on top of market incentives. Of course, the equilibrium depends on the subsidy level  $s$ , but note that  $t$  does not influence the equilibrium once participation is ensured. Hence let  $\theta_s$  and  $\mu_s$  denote the threshold and reputation under a subsidy  $s$ .<sup>6</sup> The corresponding incentive constraint now writes:

$$e(1 + s) + (1 - e)\mu_s - \theta - t \geq \mu_s - t \quad (10)$$

while Bayes' rule is as before, applied to  $\theta_s$ . Combining these two relations yields the following new equilibrium relation taking  $s$  into account:

$$F(\theta_s^*) = \frac{e(1 + s) - \theta_s^*}{e(1 + es - \theta_s^*)} \quad (11)$$

In order to ensure participation of a producer of type  $\theta$ , the scheme should provide a higher payoff than if the producer decides not to join, i.e., higher than the individual reputation payoff:

$$(1 - e)\mu_s^* - \theta - t + e(1 + s) \geq \mu^*(\theta) \quad (12)$$

Finally, the scheme is (collectively) budget balanced if the participation fees levied cover the subsidies paid:

$$t \geq es \quad (13)$$

**Proposition 7.** *Suppose the producers each have at least one unit of capital. Then the following scheme implements the first-best: the producers pay a fee  $t^* = 1$  to join the group,*

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<sup>6</sup>For convenience, we will drop the group index  $g$  in this section.

and receive a bonus subsidy  $s^* = \frac{1}{e}$  for a high price.

*Proof.* Note that as previously, equation (11) has a unique solution in  $\theta_s$ . It is straightforward to check that  $\theta_s = 1$  when  $s = \frac{1}{e}$ . As a consequence,  $\mu_s^* = 1$ . A producer's profit is then  $1 - \theta$ . The participation constraint (12) can now be written as  $\mu(\theta) + \theta \leq 1$ , or by substituting from proposition 3:  $1 - \theta \left( \frac{1}{e} - 1 \right) \leq 1$ , which always holds. Note finally that this scheme respects budget-balance, since the fee of 1 is levied on all producers, while the subsidy is paid with average probability  $e$ , for a unit cost of  $\frac{1}{e}$ .  $\square$

Importantly, this scheme is not implementable if the producers do not have capital ex-ante. But notice that an equivalent scheme can be implemented by distorting prices ex-post, such that the incentive gap is high enough. In case we impose that the resources are redistributed only ex-post, i.e. once trade has occurred, then we would like to tax unidentified products as much as we can, i.e.  $t' = 1$ , and subsidize as much  $s' = \frac{1}{e} - 1$  (note that this is just rewriting the participation fee in the ex-post instruments). This actually works and does not require ex-ante payment, hence financing from the producers. Participating in the group amounts here to buying a lottery ticket that is worth 0 without effort, but worth zero with probability  $(1 - e)$  and  $1/e$  with probability  $e$  with effort. The advantage of this implementation compared to the one in the proposition is that it does not require ex-ante financing, at the cost of substantially increasing the ex-post risk borne by the producers.

## 5 Conclusion

Collective reputations are pervasive in many industries, and often they help market players to solve informational problems that plague exchanges of quality products. In this paper we present a new model of collective reputation that is based on positive feedback on quality, i.e. where producers are facing a friendly informational environment. We analyze the incentive effects of collective reputation and show that the problem of inter-producer free riding under collective reputation may be less detrimental to quality and welfare than the problem of intra-producer free-riding in the mixed-strategy equilibria under individual reputations.

Our analysis highlights two important roles of Collective Reputations versus Individual Reputations: First, a reshuffling of quality incentives that can entail more efficient production. Second, the possibility to provide group incentives on top of market incentives—without any additional information requirements—to boost quality provision.

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