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Comparison as Incentive: Newsvendor Decisions in a Social Context

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Explicit formal mechanisms dominate the discussion about incentives in Operations Management, yet many other mechanisms exist. Social comparison between peers may provide strong implicit incentives for individuals. Social comparison arises naturally in all social settings and may thus be unintended; however, many companies deliberately use it to motivate employees. In this study, we model a social context in which purchasers evaluate their performance relative to their peers; a feeling of inferiority results in a negative contribution to utility, whereas a feeling of superiority results in a positive contribution. We find that social comparison induces characteristic deviations from the newsvendor optimum ordering decision: if fear of inferiority outweighs anticipation of superiority, then purchasers *herd* together; the converse scenario incites actors to *polarize* away from each other. In both cases, actors will deviate from ordering the newsvendor optimum in order to satisfy social goals. Demand correlation and profit margins moderate the extent of the deviation.

Key words: purchasing; organizing purchasing; newsvendor; social comparison

1. Introduction and Literature Review

Incentive theory, especially the theory of mechanism design, has become synonymous in Operations Management with the settings of adverse selection and moral hazard. A key characteristic of both—the immediate transfer of utility from the firm to its employees in exchange for a given level of output, often conceptualized as a transfer of money—has been criticized as impractical in many situations (e.g., Fehr and Falk 2002). Live organizations consciously or inadvertently use many alternative mechanisms to influence human behavior. In this study, we focus on the impact of social comparison on purchasing. Social comparison between peers provides strong implicit incentives for individuals, and it is omnipresent in virtually all organizations. We study the purchasing decisions of purchasing managers who operate in a corporate context while surrounded by and compared with people inside their organization. In addition to caring about their own performance, these managers take into account their performance relative to peers.

Our work on incentives is distinct from what many Operations Management scholars have come to associate with the concept. Economists have established an extensive theoretical methodology for providing incentives to individuals that addresses private information, private actions, and non-verifiability (e.g., Bolton and Dewatripont 2005). In its diverse instantiations, this methodology has focused on transfers of utility from the firm to the agent in exchange for favorable behavior by the agent. In theory such transfers can take on many forms, but in practice they are best viewed as transfers of money; only such transfers allow for the fine-grained differentiation between rewards for different levels of agent output that the mechanisms require. These mechanisms are intricate and therefore not easy to apply. Moreover, they may not be cost effective, especially given that, at the lower levels of a hierarchy the influence of an individual contributor on the firm's measurable output is limited. Group responsibilities prevail. So even though the insights from this incentive theory have extended our theoretical and practical understanding of some organizational situations, they describe only part of what motivates people in real-world organizations. Alternative mechanisms, such as the creation of a (competitive) culture and promotion schemes, also provide direct and indirect incentives. Such alternative methods often prove to be more practical.

Social comparison is a natural tendency in human beings (Suls et al. 2002). Many settings in which humans interact are affected by social comparison; it arises spontaneously. However, the concept is important to managers because many management practices, explicitly or implicitly, either emphasize or deemphasize social comparison. Organizations may emphasize comparison deliberately, to provide incentives, or unconsciously, sometimes to the detriment of organizational performance.

Starting with Festinger's (1954) social comparison theory, social psychologists have extensively studied the tendency innate in most human beings to evaluate one's own personal well-being in comparison with a relevant peer group. For example, Luttmer (2005) shows that a person's happiness depends strongly on how she fares relative to her neighbors. Psychologists have researched the implications of social comparison as well as the mechanisms that drive it. Social comparison is closely related to self-evaluation (Wood and Taylor 1991) and hence is related to the concept of self (Salovey and Rodin 1991). It is connected to self-esteem (Gibbons and McCoy 1991), it even factors in depression (Gibbons 1986). Social comparison is a strong motivator because most people seem naturally to derive utility from comparing themselves to others.

These natural human tendencies are often harnessed by organizations. Explicit aspects of an organization's motivational system may result in some managers striving to outperform others. Competition for status within an organization can strongly motivate individuals to take into account the decisions and outcomes realized by their peers (Sidanius and Pratto 1999). Systems that use job titles as tokens of social status have been shown to influence performance (Greenberg and Ornstein 1983). Public celebrations of success—for instance, conspicuous celebrations of individual sellers' successes (and promotions) in multilevel marketing organizations—exploit the motivational forces in social settings (Huberman et al. 2004).

Often companies do foster social comparison less consciously. The comparison embedded in many pay systems provides strong motivation. For example, Gneezy and Rustichini (2000) show empirically that workers' efforts within an organization are to a large extent determined by the comparison of their salary to that of their co-workers. Siemsen et al. (2009) show how psychological safety (and thus the potential loss of status) influence knowledge sharing in a manufacturing context.

Whether social comparison arises naturally or whether it is brought about (or extended) by management systems, comparison leads to the same effect. Whenever making a decision, the decision maker evaluates not only the inherent aspects of that decision but also how it will affect her position with respect to a reference group. So-called social utility functions (Loewenstein et al. 1989), which encompass not only outcomes for decision makers themselves but also outcomes for other individuals, have been widely studied in behavioral and experimental economics (e.g., Camerer et al. 2003, Camerer and Loewenstein 2004).

Social utility functions need to encompass both punitive and rewarding settings. A rewarding situation arises, for example, when only one of a large set of people can be rewarded (e.g., by promotion or a special prize). For instance, often the person selected to head a department comes from one of the subgroups of that department. The extent to which an individual's performance sticks out of a subgroup then becomes a measure for the promotion probability of that individual. An example of a punitive system is the setting in which the lowest-performing individuals in a department are routinely laid off (see, e.g., the description of General Electric's promotion system in Welch and Welch 2005). The extent to which an individual underperforms others in the department becomes a measure for the probability of being laid off. Hence, social comparison can engender two effects. It can induce the joy of outperforming a comparison group or the despair at being outperformed by a comparison group. Therefore, in our model the purchasing managers not only optimize expected profit under uncertainty but also weigh the outcomes with respect to positive or negative comparison within the organization.

Social comparison has an immediate relation to counterfactual thinking, especially regret aversion theory. The main concept in this theory is that an agent's decision making is influenced by her perception of what might have occurred had she made different choices (Bell 1982, Loomes and Sugden 1982, Mellers et al. 1997). Yet, because it is difficult *ex post* to judge what might have been achievable *ex ante*, managers' perceptions of forgone opportunities may lie more in the observable realizations of their peers than in any hypothetical scenario. Thus managers compare their achievements not with respect to an internal frame of reference but rather against a salient reminder of what they could have achieved: the performance of their peers.[1] For their obvious parallels we call the ill-being that results from being outperformed *social regret* and the joy of outperforming others *social rejoice*.

The behavioral operations management literature has focused on understanding—by both theoretical and empirical means—how preference structures and decision biases of the *isolated* individual induce the decision maker to deviate from risk neutral profit maximization. Thus, the literature has developed an understanding of risk aversion (Eeckhoudt et al. 1995), cognitive biases such as loss aversion (Wang and Webster 2009) or prospect theory at large (Schweitzer and Cachon 2000), learning (Bolton and Katok 2008), and the faulty assessment of information (Croson and Donohue 2006). Bounded rationality has also been shown to explain many suboptimal ordering patterns both analytically and empirically; see Su

(2008) for a model and Kremer et al. (2010) for an experimental test. There is limited work on how the social setting influences supply chain decisions. Loch and Wu (2008) establish experimentally the influence of social status on supply chain relations and Cui et al. (2007) examine how fairness considerations can imply coordination even for constant wholesale prices in a two-stage supply chain with deterministic demand.

In this study we analyze the newsvendor decision in the context of social comparison. Our contribution is twofold. First, we contribute to the academic literature by showing the impact of the organizational environment on inventory decision making. Second, we contribute to management practice by pointing out the wanted or unwanted effects that social comparison may induce in a purchasing department. We thus describe how methods that affect social comparison may affect behavior in a purchasing organization. Methods include hard factors such as the aforementioned relative monetary incentives and the success-based promotion system, and soft factors such as customs and methods used to regulate social status seeking.

2. Model

In the classic newsvendor framework, each decision maker is interested exclusively in the profit resulting from her own ordering decision. In contrast, modeling performance comparisons among purchasers requires that we complement the utility function of the classic newsvendor by incorporating aspects of how the decision makers fare with respect to their peer group. This complement has two components, the extent to which the purchaser is superior to the peer group (the social regret contribution) and the extent to which she is inferior (the social rejoice contribution). In order to build a parsimonious model, we posit the peer group as a second player in a two-player game.

Formally, purchaser i orders quantity q_i at unit cost c and of this quantity the purchaser can sell up to the stochastic demand d_i at unit revenue p. In order to prevent complexity from obscuring insights, we assume that d_i follows a uniform distribution on the interval [0,1].

In the case of being outperformed, purchaser i weights her profit inferiority with γ relative to the realized non-social newsvendor profit $\pi_i(q_i, d_i) = p \min(q_i, d_i) - cq_i$. In the case of outperforming, purchaser i weights her profit superiority with δ relative to the realized non-social newsvendor profit to form utility:

$$U_i(q_i, q_{-i}, d_i, d_{-i}) = \pi_i(q_i, d_i) - \gamma[\pi_{-i}(q_{-i}, d_{-i}) - \pi_i(q_i, d_i)]^+ + \delta[\pi_i(q_i, d_i) - \pi_{-i}(q_{-i}, d_{-i})]^+. \tag{1}$$

We assume that $\gamma \geq 0$ and $\delta \geq 0$ and $\gamma > 0$ or $\delta > 0$. Note that this assumption incorporates the cases $\gamma = 0$ and $\delta > 0$ as well as $\gamma > 0$ and $\delta = 0$. We assume that both newsvendors maximize their expected utility $E_{d_i, d_{-i}}[U_i]$ and that both players set their decisions simultaneously. Hence our model describes a two-player, simultaneous move game with common knowledge. For notational simplicity, define q_1^e and q_2^e as the equilibrium quantities ordered by the two players and $q^* = \frac{p-c}{p}$ as the non-social newsvendor profit maximizing order quantity.

2.1. Social Regret Case

For $\gamma > \delta$, the social regret component plays a larger role than the social rejoice component. We call this case the social regret case. In order to facilitate gaining insight into the impact of demand correlation, we consider analytically the cases of perfectly positively correlated demand ($d_1 = d_2$), independent demand, and perfectly negatively correlated demand ($d_1 = 1 - d_2$). We complement this analytic treatment with a simulation of intermediate cases. Propositions 1, 2, and 3 are proved in Appendix S1.

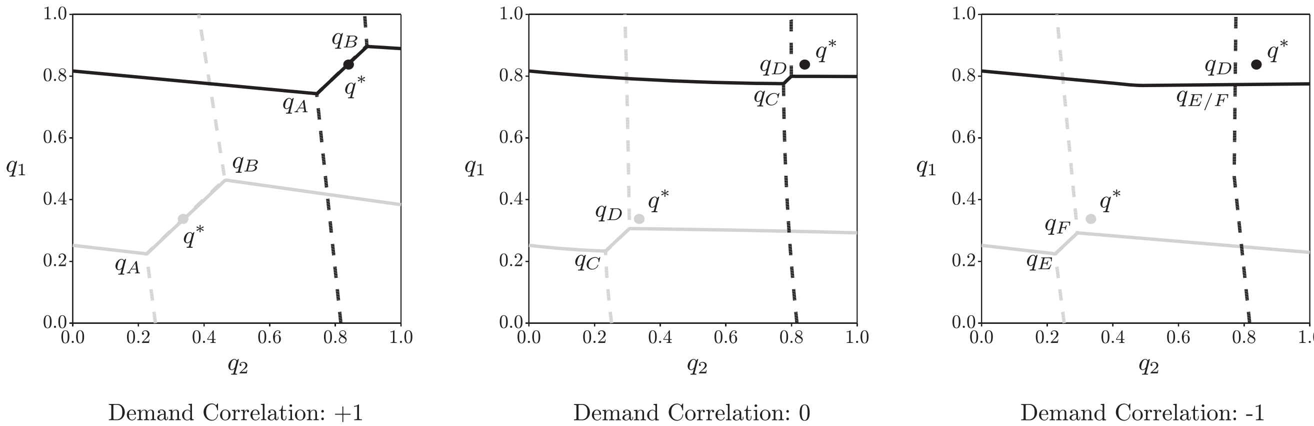
2.1.1. Perfectly Correlated Demand.

PROPOSITION 1. *All pure strategy equilibria of the game are in the set* $(q_1^e, q_2^e) = \{q_1^e, q_2^e : q_A \leq q_1^e = q_2^e \leq q_B\}$, *where* $q_A = q^* - \Delta_A$ *and* $q_B = q^* + \Delta_B$ *with* $\Delta_A = \frac{(\gamma-\delta)(p-c)c}{p((1+\delta)p+(\gamma-\delta)c)} > 0$ *and* $\Delta_B = \frac{(\gamma-\delta)(p-c)c}{p((1+\gamma)p-(\gamma-\delta)c)} > 0$. *All* (q_1^e, q_2^e) *are pure strategy equilibria.*

Proposition 1 entails several implications worth mentioning. The left-hand panel of Figure 1 (labeled "Demand Correlation: +1") highlights these implications by plotting the players' best response functions, and thus the game's equilibria, for the case of a high margin good ($p = 6$ and $c = 1$) and that of a low margin good ($p = 1.5$ and $c = 1$).

First, the game has multiple pure equilibria, in all of which both players order the exact same quantity. All these equilibria fall in the (convex and closed) set of possible order quantities, which range from the minimum quantity q_A to the maximum quantity q_B. It is interesting that, as long as $q_A \leq q_{-i} \leq q_B$, a focal player i exhibits herding behavior in that she prefers an order quantity close to the other player $-i$ over the profit maximizing order quantity q^*. Second, from the expressions for q_A and q_B it follows that the herding range is increasing in the importance of social comparison relative to profit maximization (because the region increases in γ and decreases in δ and therefore increases in the difference $\gamma - \delta$). Note that the maximum distance $q_B - q_A = 1 - 0 = 1$ is obtained as $\gamma - \delta \to \infty$. Third, since $\frac{\delta q_A}{\delta p} > 0$ and $\frac{\delta q_B}{\delta p} < 0$, the size of the herding region is less for a high margin than for

Figure 1 Best Response Functions and Equilibria for Social Regret with $\gamma = 0.9$ and $\delta = 0.1$; Solid Lines Represent the Best Response for Player 1, Dashed Lines for Player 2; Black Lines Illustrate the Case of a High Margin Good with $p = 6$ and $c = 1$, Gray Lines that of a Low Margin Good with $p = 1.5$ and $c = 1$



a low margin good. Finally, a non-social newsvendor's order quantity q^*, which maximizes expected newsvendor profit, is always in this range.

The results are intuitively appealing. When negative comparison is a factor in decision making, a purchaser seeks to limit potential social regret and thus does not want to deviate from the social norm unless it comes at a severe loss of profits. Consider, for example, the case where potential negative comparison is the sole criterion used when placing orders (i.e., $\gamma \to \infty$). Then a purchaser has no incentive to diverge from her peer's decision and will match that decision regardless of what it may be. For the more common case in which non-social newsvendor profit is *also* of importance, this tendency to comply is optimal ordering quantity has more severe implications for a high margin good than for a low margin good. Therefore, it becomes rational to abandon herding earlier for a high margin than for a low margin good.

In sum, companies that emphasize negative comparison (by e.g., instilling a culture of fear) may induce detrimental behavior in their purchasers. It is interesting that this behavior may be especially severe for companies with low margins to start with.

2.1.2. Independent Demand.

Proposition 2. *All pure strategy equilibria of the game are in the set* $(\hat{q}_1^e, \hat{q}_2^e) = \{\hat{q}_1^e, \hat{q}_2^e : q_C \le \hat{q}_1^e = \hat{q}_2^e \le q_D\}$, *where* $q_C = q^* - \Delta_C > q_A$ *and* $q_D = q^* - \Delta_D < q_B$ *with*

$$\Delta_D = \frac{p\sqrt{-(\gamma-\delta)(2+\delta+\gamma)c^2 + 2(\gamma-\delta)(2+\delta+\gamma)pc + (1+\delta)^2 p^2} - (1+\delta)p^2 - (\gamma-\delta)(2p-c)c}{(\gamma-\delta)(2p-c)p} > 0$$

and $\Delta_C = \dfrac{p\sqrt{(\gamma-\delta)c^2(2+\delta+\gamma) + (1+\delta)^2 p^2} - (\gamma-\delta)c^2 - (1+\delta)p^2}{(\gamma-\delta)pc} > 0$. *All* $(\hat{q}_1^e, \hat{q}_2^e)$ *are pure strategy equilibria.*

bounded by q_A and q_B. To see why these bounds exist, consider two players who decrease their ordering quantities synchronously starting from the optimal ordering quantity q^*. As they do so, the loss of expected profit—and hence the benefit of deviating from the other player's ordering quantity—increases. Eventually there is a cutoff and deviation becomes the optimal choice. Observe in this regard that in the left-hand panel of Figure 1, as player 2 orders further below (above) q_A (q_B), the best response of player 1 moves in the opposite direction. Because the herding region is increasing in $\gamma - \delta$, stronger social comparisons allow for larger deviations from the profit maximizing solution q^*. Finally, deviating from the

Proposition 2 mirrors Proposition 1 and establishes, for the case of independent demand, that there exists a herding region: negative comparison incentivizes purchasers to herd together in order to reduce potential social regret (see the middle panel in Figure 1, labeled "Demand Correlation: 0"). The region is a subset of the herding region for perfectly correlated demand, $[q_C, q_D] \subseteq [q_A, q_B]$. Again the herding region is increasing in the importance of social comparison ($\gamma - \delta$), and again it is smaller for the low margin than for the high margin good; hence higher margin goods are less prone than are lower margin goods to profit deformations by social comparison. Thus, the main insights of the perfectly correlated demand case apply.

However, with respect to the case of perfectly correlated demand, two key differentiating effects emerge in the case of independent demand. First, the range of potential equilibria is narrower. It is intuitive that the possibility of different demand realizations implies that even matching the other player's quantity could entail a negative utility contribution in the regret component. Suppose the first player orders a high quantity that is likely to be much greater than realized demand. Then, the second player's order of the same quantity no longer constitutes a perfect hedge, because now there exist demand realizations such that the first player faces high demand but the second player does not. So after matching the first player's order quantity, the second player makes a lower profit than the first and thus experiences regret. Similarly, matching an extremely low order quantity does not form a perfect hedge, either. Thus, mimicking the first player's behavior becomes less attractive.

The second difference is that, compared with the case of perfectly correlated demand, the herding region under independent demand is shifted lower[2] to the extent that the profit maximizing quantity is beyond the herding region, $q^* > q_D$. In order to develop some intuition for this effect, we restrict our attention to cases in which each player orders the same quantity. It is interesting that only by ordering $q_i = q_{-i} = 0$ do the players experience zero expected regret—in contrast to the perfectly correlated demand case, where ordering the same order quantity always yields zero expected regret. As the common order quantities increase, the magnitude of expected regret also increases for each player; thus, the higher the order quantity, the higher the magnitude of expected regret. Therefore, players who want to avoid expected regret must order low quantities which shifts the herding region downward.

2.1.3. Perfectly Negatively Correlated Demand.

Proposition 3. *(i) If* $p < \frac{(2+\gamma+\delta)c}{1+\delta}$ *then all the game's pure strategy equilibria are in* $(\bar{q}_1^e, \bar{q}_2^e) = \{\bar{q}_1^e, \bar{q}_2^e : q_E \leq \bar{q}_1^e = \bar{q}_2^e \leq q_F\}$, *where* $q_E = q^* - \Delta_E$ *and* $q_F = q^* - \Delta_F$ *with* $\Delta_E = \frac{(\gamma-\delta)(p-c)c}{p((1+\delta)p+(\gamma-\delta)c)} > 0$ *and* $\Delta_F = \frac{(\gamma-\delta)(p-c)^2}{p((1+\delta)p+(\gamma-\delta)(2p-c))} > 0$. *All* $(\bar{q}_1^e, \bar{q}_2^e)$ *are pure strategy equilibria.*

(ii) If $p \geq \frac{(2+\gamma+\delta)c}{1+\delta}$ *then there is exactly one pure strategy equilibrium* $(\bar{q}_1^e, \bar{q}_2^e)$, *where* $\bar{q}_1^e = \bar{q}_2^e = q^* - \Delta_G$ *with* $\Delta_G = \frac{(\gamma-\delta)c}{2(1+\delta)p} > 0$.

Proposition 3 establishes the validity of all our previous results for perfectly negatively correlated demand; negative comparison incentivizes purchasers to herd together; the higher the aversion to social regret, the wider the range in which purchasers try to match each other; higher margin goods are less prone to profit deformations than are lower margin goods. As compared with the other two cases, the herding region becomes even smaller and shifts further downward. However, as illustrated by the best response functions in the right-hand panel in Figure 1 (labeled "Demand Correlation: −1"), the case of perfectly negatively correlated demand requires elaboration.

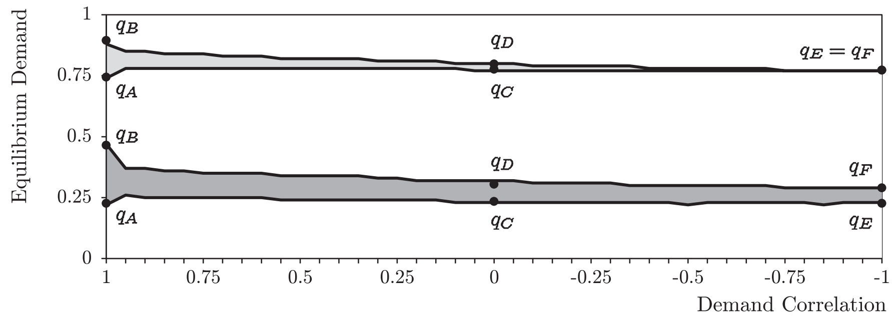
Proposition 3 establishes two distinct regimes. For low margin goods, there is again a convex and closed herding region. For combinations of low social regret and high margins, however, the herding region may collapse to a single point. This single equilibrium point implies common ordering quantities lower than the optimal ordering quantity q^*. We therefore view the collapse as a special case of profit-deforming herding.

2.1.4. General Demand Correlation.

Generalizing the correlation structure for demand d_1 and d_2 requires that we make additional assumptions about their joint distribution function. For perfectly positively correlated demand, independent demand, and perfectly negatively correlated demand, our assumption of a uniform marginal distribution fully specifies the joint distribution of d_1 and d_2. In contrast, for $\rho \notin \{-1,0,1\}$ we must define the joint distribution function explicitly. For the sake of model consistency we maintain the assumption of uniform marginal distributions for d_1 and d_2 and thus resort to copula statistics. A *copula* is a joint partial distribution function whose marginal partial distribution functions are uniform on the unit interval. Several families of copulas have been characterized, such as the Archimedan, the periodic, and the Gaussian opula. We base our analysis on the Gaussian copula, since it has become popular in applied research (Li 2000). Its probability distribution function (pdf) is defined as $c(x,y) = \frac{\phi_B(\Phi^{-1}(x),\Phi^{-1}(y),\rho)}{(\phi(\Phi^{-1}(x))\phi(\Phi^{-1}(y))}$, where $\phi_B(u,v,\rho) = \frac{1}{2\pi\sqrt{1-\rho^2}} e^{-\frac{1}{2}(1-\rho^2)\cdot\, [u^2+v^2-2uv]}$, ϕ the pdf of the standard normal distribution, Φ the cumulative distribution function (cdf) of the standard normal distribution, and ρ the correlation coefficient.

From the pdf of the Gaussian copula it is immediately apparent that our model cannot be treated analytically for general demand correlation. (Neither could it be for any of the other families of copulas that allow for arbitrary correlation structures.) We therefore turn to a numerical treatment. Figure 2 shows the equilibria for correlations between $\rho = 1$ and $\rho = -1$. Following the insights from our analytical section, we show examples for both a high margin and a low margin case. In addition to the numerical results, the figure also plots the theoretical predictions from our closed-form analysis.

Figure 2 **Herding Equilibria for Social Regret with $\gamma = 0.9$ and $\delta = 0.1$; the Light Gray Region Illustrates the Equilibria for a High Margin Good with $p = 6$ and $c = 1$, the Dark Gray Region for a Low Margin Good with $p = 1.5$ and $c = 1$; Demand Correlation Is Simulated from -1 to 1 in Steps of 0.05; the Dots are Predictions from the Closed-Form Analysis**



First, as a matter of internal consistency, we find that the numerical and the analytical results coincide (what small deviations remain can be attributed to the unavoidable rasterization of the simulated best response functions). Second, and more importantly, the graphs for arbitrary demands reinforce our findings from the analytical sections. In particular: negative comparison induces herding; herding is pronounced in the importance of social comparison; higher margin goods are less affected by herding behavior than are lower margin goods; decreasing demand correlation reduces the width of the herding region (for negative correlation and low margin goods possibly to a single point) and the center of the herding region moves lower as demand correlation decreases. Third, as an additional point, the width of the herding region changes very gradually with changes in correlation, except there is a marked shift in the width of the herding region for a change in correlation from +1 to +0.95. Given these results, avoiding a setup in which purchasers face perfect positive demand correlation is one way to mitigate the negative effects of social regret.

2.2. Social Rejoice Case

For $\delta > \gamma$, the social rejoice component plays a larger role in decision making than the social regret component. We call this case the social rejoice case. Once again we begin by considering analytically the cases of perfectly positively correlated demand, independent demand and perfectly negatively correlated demand and then treat numerically the intermediate cases. Proposition 4, 5, and 6 are proved in Appendix S2.

2.2.1. Perfectly Correlated Demand.

PROPOSITION 4. *There are exactly two pure strategy equilibria of the game:* $(q_1^{e,1}, q_2^{e,1})$ *and* $(q_1^{e,2} q_2^{e,2})$, *where* $q_1^{e,1} = q_2^{e,2} = q^* + \Delta_H$ *and* $q_1^{e,2} = q_2^{e,1} = q^* - \Delta_J$ *with* $\Delta_H = \frac{(p-c)c(\delta-\gamma)((1+\gamma)p+(\delta-\gamma)c)}{(1+\delta)p(-2c^2(\delta-\gamma)+2pc(\delta-\gamma)+(1+\gamma)p^2)} > 0$ *and* $\Delta_J = \frac{(p-c)c(\delta-\gamma)((1+\delta)p-(\delta-\gamma)c)}{(1+\delta)p(-2c^2(\delta-\gamma)+2pc(\delta-\gamma)+(1+\gamma)p^2)} > 0.$

Proposition 4 has three main implications, which are illustrated by the two players' best response functions as depicted in the left-hand panel of Figure 3 (labeled "Demand Correlation: +1"). First, there are exactly two pure strategy equilibria. These equilibria are *asymmetric* in the sense that both players always order different quantities: one player orders more and the other player less than the non-social newsvendor optimum q^*. Yet, they are also *symmetric* in the sense that both equilibria consist of the same set of order quantities; they differ only in whether player 1 or player 2 orders the higher or lower quantity, respectively. Second, the difference between these two quantities is increasing in the importance of social rejoice, $\delta - \gamma$. Finally, this difference is higher for a low margin good than for a high margin good.

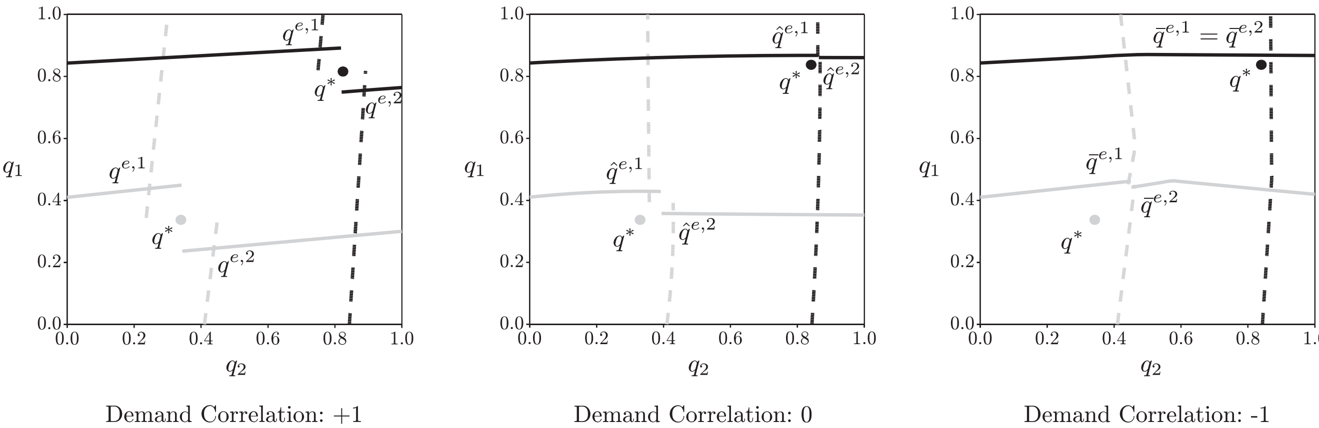
Social rejoice makes an interesting contrast to social regret. Social rejoice induces players to differentiate themselves from each other. Thus it results in polarization, the opposite of herding. Purchasers engage in risky behavior to be "ahead of the pack" should extreme demand be realized and they disregard the loss that such behavior yields in the (more likely) case of normal demand. However, social rejoice does share some characteristics with social regret. Organizational mechanisms that encourage social rejoice also induce detrimental behavior; this behavior is more prominent if the social rejoice component is emphasized and if margins are higher (since a deviation from the optimal order quantity entails more lost profit in expectation).

2.2.2. Independent Demand.

PROPOSITION 5. *There are exactly two pure strategy equilibria of the game,* $(\hat{q}_1^{e,1}, \hat{q}_2^{e,1})$ *and* $(\hat{q}_1^{e,2}, \hat{q}_2^{e,2})$, *where* $q^* < \hat{q}_1^{e,2} = \hat{q}_2^{e,1} < \hat{q}_1^{e,1} = \hat{q}_2^{e,2}$.

Proposition 5 exhibits the same key characteristics as Proposition 4 for perfectly correlated demand, as shown by the best response functions in the middle panel of Figure 3 (labeled "Demand Correlation: 0").

Figure 3 **Best Response Functions and Equilibria for Social Rejoice with $\gamma = 0.1$ and $\delta = 0.9$; Solid Lines Represent the Best Response for Player 1, Dashed Lines for Player 2; Black Lines Illustrate a High Margin Good Case with $p = 6$ and $c = 1$, Gray Lines a Low Margin Good Case with $p = 1.5$ and $c = 1$**



That being said, two aspects of the independent demand scenario are worthy of additional comment. First, under perfectly correlated demand, purchasers can experience social rejoice in expectation only by differentiating their order quantities. Yet under independent demand the independent realizations themselves create the opportunity for profit differentiation, so purchasers feel less need for quantity differentiation. As a consequence, they polarize less. Second, the magnitude of profit differentiation provided by demand differences is higher, the less that demand is censored by order quantities. Thus, on average the players' order quantities are driven upward in this case.

2.2.3. Perfectly Negatively Correlated Demand.

Proposition 6. *(i) If $p(1 + \delta) < (2 + \delta + \gamma)c$ then there are exactly two pure strategy equilibria of the game, $(\bar{q}_1^{e,1}, \bar{q}_2^{e,1})$ and $(\bar{q}_1^{e,2}, \bar{q}_2^{e,2})$, where $\bar{q}_1^{e,1} = \bar{q}_2^{e,2} = q^* + \Delta_K$ and $\bar{q}_2^{e,1} = \bar{q}_1^{e,2} = q^* + \Delta_M$ with $\Delta_K = \frac{(1+\gamma)(\delta-\gamma)(p-c)c}{(1+\delta)((1+\gamma)p^2-(\delta-\gamma)(p-c)^2)-(1+\gamma)(\delta-\gamma)c^2} > 0$ and $\Delta_M = \frac{(1+\delta)(\delta-\gamma)(p-c)^2}{(1+\delta)((1+\gamma)p^2-(\delta-\gamma)(p-c)^2)-(1+\gamma)(\delta-\gamma)c^2} > 0$.*
(ii) If $p(1 + \delta) \geq (2 + \delta + \gamma)c$ then there is exactly one pure strategy equilibrium of the game $(\bar{q}_1^e, \bar{q}_2^e)$, where $\bar{q}_1^e = \bar{q}_2^e = q^* + \Delta_N$ with $\Delta_N = \frac{(\delta-\gamma)c}{2p(1+\delta)} > 0$.

The result for perfectly negatively correlated demand replicates the main results of the other cases (for an illustration see the right-hand panel of Figure 3, labeled "Demand Correlation: −1"): social rejoice leads to polarization that is amplified in the importance of the social rejoice contribution $(\delta - \gamma)$ and that increases for low margin goods. In addition, the main trends persist: perfectly negative demand correlation brings about profit differentiation even without polarization, so the need for polarization is decreased even further as compared with perfectly positively correlated demand or independent demand. Moreover, there is a continued trend to increase ordering quantities, since high demand realizations for a focal player are guaranteed to coincide with low realizations for the other player.

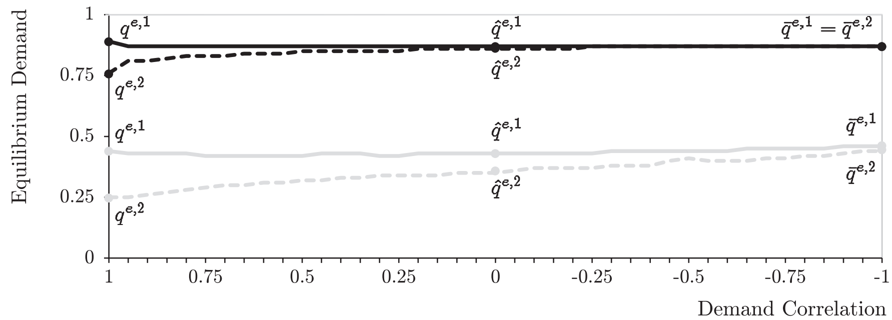
One aspect does require discussion. For low margin goods, social rejoice induces polarization as before. For high margin goods, however, the two polarized equilibria may collapse into a single point. Both players order the same quantity, which is greater than the newsvendor optimum. Much as with the case of herding, we view the collapse as a special case of rejoice since the equilibrium quantity still implies profit distortion.

2.2.4. General Demand Correlation. Figure 4 shows the results of the numerically calculated equilibria of the social rejoice case for correlations between $\rho = 1$ and $\rho = -1$. We display two exemplary cases that address the two mathematical subcases of Proposition 6. The graphs also plot the analytical predictions from our closed-form analysis. Analytic results and simulation results match nearly perfectly, thus establishing the soundness of our simulations. As was the case for social regret, the simulation reinforces the findings from the analytical sections.

2.3. Extending the Model to Inequity Aversion

In the 1960s and 1970s, social psychologists began formally researching the common desire to establish equitable societies (Walster et al. 1973). Experiments have since demonstrated that human beings may derive utility from equity of outcomes relative to a peer group (e.g., Dawes et al. 2007). Recent results from neuronal analysis suggest that human beings are in fact hard-wired to react to inequity (Triconi et al. 2010). Hence motives of equality must be viewed as natural and universal in human beings.

Figure 4 **Equilibria for Social Rejoice with $\gamma = 0.1$ and $\delta = 0.9$; Black Lines Represent the x and y Coordinates of the Equilibria of a High Margin Good with $p = 6$ and $c = 1$, the Gray Lines those of a Low Margin Good with $p = 1.5$ and $c = 1$; Simulation for Demand Correlation from -1 to 1 in Steps of 0.05; the Dots Are Predictions from the Closed-Form Analysis**



The supply chain literature has begun to consider such equality motives. Cui et al. (2007) and Caliskan-Demirag et al. (2010) look at supply chain coordination and find that fairness considerations—concerning the distribution of profits between a manufacturer and a retailer—may allow for simpler coordinating contracts as compared to the standard case. Katok et al. (2011) explore the implications for supply chain efficiency of the two partners not being informed about their respective fairness preferences.

Since in this study we are concerned with the influence of organizational forces on purchasing decisions, we have to consider equality. Egalitarian motives (and the closely related motives of justice) have spawned many different detail conceptualizations. There are conceptualizations that define equality and justice over intentions (Fehr and Schmidt 2006, Rabin 1993). What a decision maker intends is the basis for judging the justice of actions. While this is a useful conceptualization in everyday life, in the context of (organizational) incentives it is preferable to define equality over outcomes: In a business setting, such as ours, outcomes tend to play a more important role in motivating individuals than do intentions.

The concrete conceptualization that is immediately relevant to our model is inequity aversion (Bolton and Ockenfels 2000, Fehr and Schmidt 1999). Inequity aversion postulates that any deviation from equality gives a negative contribution to utility. As a result, both a positive and a negative deviation from a group norm is viewed as undesirable. Fehr and Schmidt (1999) introduce a social utility function that—using our notation—defines inequity aversion as

$$\bar{U}_i(q_i, q_{-i}, d_i, d_{-i}) = \pi_i(q_i, d_i) - \alpha[\pi_{-i}(q_{-i}, d_{-i}) - \pi_i(q_i, d_i)]^+ - \beta[\pi_i(q_i, d_i) - \pi_{-i}(q_{-i}, d_{-i})]^+ \quad (2)$$

with inequity parameters $\alpha, \beta > 0$. For purely technical reasons we assume that $\beta < 1$. Then,

Lemma 1. *In our games, there is a choice of social regret parameters γ and δ such that for any choice of α and β, there is an equivalent formulation of the best response functions for inequity aversion and social regret. Equivalence can always be attained for $\frac{(\gamma-\delta)}{(1+\delta)} = \frac{(\alpha+\beta)}{(1-\beta)}$.*

The technical formulation of Lemma 1 masks a simple insight. Although the utility functions for social regret and inequity aversion are technically different, they induce structurally the same equilibria for our games. Specifically, for $\frac{(\gamma-\delta)}{(1+\delta)} = \frac{(\alpha+\beta)}{(1-\beta)}$ they imply the exact same equilibria. Hence, as a consequence of Lemma 1, we can immediately apply our equilibria results for the social regret case to the inequity aversion case by replacing the term $\frac{(\gamma-\delta)}{(1+\delta)}$ in the equilibria solutions of social regret by $\frac{(\alpha+\beta)}{(1-\beta)}$. Lemma 1 ensures that this is possible.

Lemma 1 then allows for a few simple conclusions. As was the case for social regret, (i) inequity aversion inadvertently induces herding behavior, (ii) as demand correlation increases the herding region ultimately increases as well, (iii) higher margin goods are less prone to profit deformations than are lower margin goods. However, it is also informative to focus on the differences between inequity aversion and social regret. Herding behavior is more pronounced for inequity aversion than for social regret: for social regret the herding region only increases in one parameter (as $\frac{(\gamma-\delta)}{(1+\delta)}$ only increases in γ), while for inequity aversion the region increases in both (as $\frac{(\alpha+\beta)}{(1-\beta)}$ increases in both α and β). Moreover, when setting $\alpha = \gamma$ and $\beta = \delta$ the herding region is wider for inequity aversion than for social regret since $\frac{(\alpha+\beta)}{(1-\beta)} > \frac{(\gamma-\delta)}{(1+\delta)}$. In sum, Lemma 1 implies that in our games, inequity aversion induces the players to behave as if it was an extreme form of social regret.

The technical reason for the similarity of the two concepts lies in the utility functions: Mathematically using $[\pi_{-i}(q_{-i}, d_{-i}) - \pi_i(q_i, d_i)]^+ = [\pi_i(q_i, d_i) - \pi_{-i}(q_{-i}, d_{-i})]^+ + \pi_{-i}(q_{-i}, d_{-i}) - \pi_i(q_i, d_i)$ the utility for social regret can be written as $U_i(q_i, q_{-i}, d_i, d_{-i}) = (1+\delta)\pi_i(q_i,d_i) - \delta\pi_{-i}(q_{-i},d_{-i}) - (\gamma-\delta)[\pi_{-i}(q_{-i},d_{-i}) - \pi_i(q_i,d_i)]^+$ and for inequity aversion as $\bar{U}_i(q_i,q_{-i},d_i,d_{-i}) = (1-\beta)\pi_i(q_i,d_i) + \beta\pi_{-i}(q_{-i},d_{-i}) - (\alpha+\beta)[\pi_{-i}(q_{-i},d_{-i}) - \pi_i(q_i,d_i)]^+$. When a player optimizes $E[U_i]$ ($E[\bar{U}_i]$) so as to derive her best response function, she can neglect the term $\delta E[\pi_{-i}]$ ($\beta E[\pi_{-i}]$) because it does not depend on q_i. So in both equations the second term on the right-hand side can be dropped. But then both equations are structurally equivalent. This structural equivalence explains the similarities in the effects that the two concepts bring about. Comparing the two equations, the coefficient in front of the newsvendor profit is smaller for inequity aversion while the coefficient in front of the last term is larger. This shift in emphasis explains the increased size of the herding region for inequity aversion.

The similarity of the two concepts is in fact intuitive. In the case of social regret, the manager feels joy when outperforming others. However, the fear of being outperformed is stronger and hence herding results. In contrast, in the case of inequity aversion, the manager does not feel joy when outperforming others but rather fears both outperforming and being outperformed. Since it is this dominant fear that drives herding behavior, both concepts imply herding. However, there are more outcomes to be fearful of for inequity aversion than for social regret and hence herding behavior is pronounced.

3. Discussion

Purchasers rarely operate in isolation. Rather, they are typically part of an organizational structure or social system. This study considers a social comparison context in which two basic situations arise. A purchaser feels *social regret*, a negative contribution to utility, if she is inferior to a peer or feels *social rejoice*, a positive contribution to utility, if she is superior. Our analysis suggests that social regret induces herding behavior among purchasers. In order to avoid feeling discomfort about coming up short in a social comparison, purchasers faced with uncertainty converge to a common ordering decision. Social rejoice, in contrast, induces polarization among purchasers. In order to create the opportunity for being superior in a social comparison, purchasers seek to occupy their own niche. Interestingly, inequity aversion, in which purchasers feel discomfort about both being superior and inferior has the same effects as a strong case of social regret. In all situations, purchasers are willing to sacrifice some expected profit in order to further their social and organizational aims. Social comparison usually induces behavior that does not yield profit maximization for the firm.

Organizations tend, informally or formally, to reinforce social comparison through their incentive and management systems. Examples include informal praise or critique and the resulting change of status. More formal means include bonus payments for above-average performance and improved chances of career progression. However, mechanisms that encourage social comparison may also cause detrimental behavior. An outside observer might easily construe such behavior as part of the company culture: "This is how things are done around here!" Yet because the behavior is based on purchasers' utility functions, it is time invariant and persists in the organization. For this reason, attempts to change the situation that are based mainly on process improvement and do not take the phenomenon's organizational roots into account, are likely to be ineffectual. This means that realizing how social regret (or inequity aversion) and social rejoice distort optimal decision making has implications for how firms should manage purchasing organizations.

So why, then, do companies (and not just multilevel marketing companies) make such prominent use of social comparison? As in any newsvendor model that we are aware of, in our model the decision maker does not have to exert effort. Hence our model (as do the others) clearly abstracts from an important organizational reality. Of course, motivating personnel to work hard is a substantial management problem. Purchasing requires analytical effort, especially since purchasers have responsibilities beyond setting order quantities such as finding suppliers and evaluating their competence. Some purchasers may be unwilling to expend effort without encouragement. Using social comparison is typically viewed as an appropriate method for inducing such effort. A manager of a live organization needs to balance these known motivational effects of social comparison with its downside, the distorting behavior highlighted by our model.

For managers who consider using social comparison, our model yields some practical insights on when and how to use social regret (or inequity aversion) and social rejoice most efficiently. First, for high levels of positive demand correlation, the herding region contains the optimal order quantity. As correlation declines, the herding region is pushed increasingly lower and so eventually excludes the newsvendor optimum. Note also that the herding region is largest when demand is perfectly positively correlated. Hence, whenever managers employ social regret (or inequity aversion), they should try to distribute purchasing tasks in such a way that outcomes show positive correlation just shy of perfect correlation; managers should then employ secondary mechanisms to steer decision making as close as possible to the actual optimum. Similarly, whenever managers try to use social rejoice as a motivational tool, they should avoid high levels of demand correlation and prefer moderate levels of positive correlation in order to minimize the negative effects of polarization.

Our second practical insight is that social regret (or inequity aversion) induces (or, at least, allows for) larger deviations from the optimal order quantity for low margin goods than for high margin goods. Margins have a more nuanced effect in the case of social rejoice, but low margin goods generally induce more polarization than do high margin goods. Therefore organizations that focus on high margin goods can cope with the negative effects of social comparison better than organizations that focus on low margin goods. In such high margin companies, the positive motivational effect outweighs the negative effect of more easily distorted decisions, so using social comparison becomes more appropriate.

Finally, social effects hinge on the observability of those aspects that are being compared. The performance of the comparison group must therefore be transparent. This requirement has two implications. On the one hand, a lack of transparency curtails the tendency to compare; hence it can be used as a mechanism to reduce unwanted social comparison in situations where it arises naturally. On the other hand, if management wants to harness the power of social comparison, then transparency is indispensable.

Obviously, our model has limitations that need to be considered when interpreting the results. First of all, in order to not let technical detail obscure the interpretation of results, we limited mathematical complexity. We analyze two-player games and we assume linear regret and rejoice as well as a uniform demand distribution. We would expect the results to mirror ours for non-linear regret and non-uniform distributions—although closed form expression may not be possible. Increasing the number of players in the game, however, may yield additional insights because more complex behavioral patterns may become desirable. Second, our results are based on mathematical modeling. Therefore, they build strong hypotheses as to which behaviors to expect in situations of social comparison. However, the practical relevance of our predictions can only be verified through experiments and ultimately through an empirical analysis. In future studies, we plan to understand the effects of social comparison better through lab experiments, not only to verify our model but also to advance it.

In this study, we have used a parsimonious model to take some initial steps toward understanding the influence of the social context on purchasing behavior as well as the distorting effects of that influence. We have thus begun to address the imbalance between actual purchasing managers' strong focus on organizational issues and the dearth of reflection on such issues in operations management research.

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Notes

[1]An intriguing example of this mechanism is the "postal code" lottery conducted in the Netherlands (Zeelenberg and Pieters 2004), where each lottery ticket is linked to the owner's postal code. Thus, an individual who decides not to buy the ticket faces the prospect of strong future regret if his postal code is selected, for then all his ticket-buying neighbors will have won while he is left out.
[2]More precisely, the middle point of the herding region is shifted downward.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Appendix S1. Proofs for the Regret Case.
Appendix S2. Proofs for the Rejoice Case.