Gainsharing Issues in Marketing

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Abstract

From frequent flyer awards to salesforce perquisites, from peer-to-peer awards to university systems in formerly Communist countries, gainsharing is common. By gainsharing we mean a side payment from an upstream agent (an airline) to a downstream agent (a frequent flyer) in return for a higher evaluation (the flyer chooses the airline and the firm pays the airline because the flyer chose it). In particular, we analyze side payments in situations where the evaluation-for-side-payment contract is public knowledge and, implicitly, enforceable. We argue that, for continuous upstream and downstream reward systems, (1) gainsharing will almost always occur and (2) the firm can design reward systems to factor out the gainsharing without any loss of profits. Our analyses highlight the conditions that favor gainsharing and illustrate how and when the firm can take gainsharing into account.
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There are two things that can be said about bribery. (1) Most of the world does it and (2) most of the world thinks it’s bad. The former is prima facia evidence that individual actors find side payments to be efficient. The latter expresses the belief that, somehow, side payments hurt the firm.

This paper does not address bribery in all its instances nor do we address the very real moral issues that surround the topic, but we attempt to provide insight into a limited form of side payments that are quite relevant to marketing.¹ We limit our focus to side payments that the firm (or principal) can anticipate and to situations that can be modeled as a vertical chain. For these situations we examine conditions under which the structure of the reward system encourages side payments and conditions under which such side payments do not reduce the profits of the firm.

We begin with a series of examples in which a downstream (D) agent evaluates an upstream (U) agent, perhaps implicitly, and the firm pays the upstream agent based on that evaluation. In each case there is some (implicit) cost to the downstream agent for providing a higher evaluation. We then formalize the problem and demonstrate two results.

Examples

Frequent Flyer Awards

Airlines (U) compete to serve frequent flyers (D) by giving them awards based on the number of miles that the frequent flyers fly with the airline. The flyer "evaluates" the airline by choosing that airline over competitive alternatives for the same route. The firm pays the airline based on the flyer’s choice. However, the airline, not the firm, rewards the flyer directly for his or her choice of airline.

In a recent exchange IBM tried to recapture the benefit of frequent flyer miles by negotiating directly with American Airlines and United Airlines for "discounts on business travel in exchange for eliminating frequent flyer mileage credits to IBM employees, the answer was no." (Boston Globe, March 13, 1994). The Globe went on to talk about how frequent flyer miles build a relationship between the airline and the employee rather than the airline and the firm and speculated that IBM would not gain enough additional dollars to offset the value of the lost employee moral. The Globe even speculated that frequent flyer miles enhance American productivity.

¹Our interest in this topic is scientific. We wish to understand the phenomenon. Nothing in this paper should be interpreted as advocating the schemes we describe.
Frequent flyer programs are public knowledge. It is reasonable to expect that IBM and other firms can anticipate the rewards that their employees receive and take those rewards into account when setting employee salaries. It might even be easier for American Airlines and United Airlines to administer those rewards than it would be for IBM.

**Sales Perquisites**

Most professional sports arenas have skyboxes and most skyboxes are leased to corporate sponsors. We are familiar with many organizations that encourage their salespeople to use the skyboxes to entertain customer representatives. The customer representatives are, in turn, making buying decisions for their firms. Here the customer representative (D) "evaluates" the salesperson (U) by placing a buy order for the selling firm's goods or services. The selling firm pays the salesperson a commission for that order. The invitation to the skybox can be interpreted as a payment from the salesperson to the customer representative. Certainly the customer representative benefits directly. From the salesperson's perspective the skybox is a limited resource that is allocated to the customer representative rather than to the salesperson's friends and family. (The latter is not unheard of in the business.) In other situations, the salesperson pays for the perquisite directly (lunch, coffee, gifts under $25).

Most industries have "norms" under which salespeople operate. For example, "professional sports tickets are okay, but cash payments are not." These rules are often codified in corporate policies and/or federal tax codes. In such industries it is reasonable to expect that the selling firm can anticipate the salesperson's side payments and reimburse him or her for those side payments -- sometimes directly with an expense report. Similarly, the buying firm can anticipate the side payments to the customer representative and take them into account in setting the overall compensation to the buying representative.

Gifts giving is a related example. For example, Murphy (1995) publishes holiday gift-giving guidelines. Qualitative discussions with Japanese students suggest that, not only is gift-giving an accepted business practice, but there are strong cultural guidelines for the value and type of gifts, and for which business situations require gifts. It is reasonable to assume that Japanese firms can anticipate the costs and benefits to employees of gift exchanges.
Internal Customer Satisfaction Systems

Zeithaml, Parasuraman, and Berry (1990) advocate internal customer systems in which the internal customer (D) rates its internal supplier (U) on a customer-satisfaction score. For example, the sales organization may be asked to evaluate the sales-support materials provided by the marketing department. In many of these situations the internal supplier is rewarded by the firm when it receives higher evaluations from the internal customer. Rewards can include pride, promotions, or even monetary incentives. For example, both Chester (1995) and Shapria and Globerson (1983) describe systems in which rewards are continuous functions of the score the internal supplier receives.²

We have heard informally that internal suppliers often reward internal customers for higher ratings. Such rewards take the form of extra-normal service that increases the well-being of the internal customer rather than directly increasing the satisfaction of the external customer. Such extra-normal service is not hidden from the firm and, in principle, the firm can anticipate this extra-normal service in setting the compensation for both the internal customer and the internal suppliers.

Customer Satisfaction Incentives for Auto Dealers

One major US auto firm pays a bonus of $25 to an auto salesperson (U) whenever the customer (D) rates that salesperson highly on customer satisfaction. The firm's consultants are aware that some of the $25 makes its way to customers in the form of gifts (candy, flowers, etc.). The firm's goal is to satisfy customers. It recognizes that, initially, it might have to pay customers for that satisfaction. It hopes that, in the long-run, the salesforce will find more efficient ways to serve customers that "cost" the salesperson less and satisfy the customer more than gifts.

Quality Movement

Many authors in the quality movement advocate that gains be shared among employees (Bullock and Tubbs 1990, Chester 1995, Cotada 1993, Kuczmarski 1992). Sometimes this is explicit in the form of "peer-to-peer" awards; other times it is implicit.

²GM Hughes, a $1.4 billion firm with $700 million in R&D spending, uses a gainsharing system, called "results sharing," in which business units evaluate R&D and in which R&D's salary is based on a piecewise linear function of that evaluation (Chester 1995).
In some situations, a downstream producer is asked to rate an upstream supplier. For example, Starcher (1992) gives an example that was not effective. "Subassembly" (U) was given an aggressive goal to reduce the number of defects found on inspection. This goal was achieved when "inspection" (D) found fewer faults and passed on more defects to the final assembly area (requiring more rework). Presumably, "inspection" gained implicit benefits from helping their friends and colleagues and, presumably, these benefits outweighed any costs due to raising "inspection’s" evaluation of "subassembly’s" work. Although Starcher’s example was not efficient for the firm, we might imagine other situations in which the firm holds "inspection" more accountable for the rework. With the right incentives "inspection," with its detailed knowledge of the "subassembly" employees, might make decisions that maximize the firm’s profitability.

In another failed experiment a computer firm decided to pay its quality assurance people (D) $20 for every bug they could find and programmers (U) $20 for every bug they fixed. Almost immediately an economy in "bugs" developed with employees making as much as $1700 per week before the firm put an end to the program (Adams 1995). While these examples were counter-productive for the firm, they do illustrate that gainsharing will occur and that it will affect employee actions. They do not rule out the possibility that a better designed reward system could take gainsharing into account.

Universities in Formerly Communist Countries

Sidrys and Jakštaitė (1994) describe a situation at Vytautas Magnus University, Kaunas Technical University, and Vilnius University where a higher grade translates directly into a higher monthly stipend from the university. In turn, "some doctoral students of computer science were more or less required to help build their professor’s summer cottage." "There is a widespread practice of parents bribing instructors to alter exam grades." The authors report that this practice was much more common for local (Lithuanian) professors than it was for foreign (mostly American) professors who were not versed in the local culture. Interestingly, while local and foreign instructors varied on many measures, the smallest variation was on the outcome measure, "how much the students felt they had learned from their instructors."

In this situation grades have ceased be a clear signal of hard work (although better students might have to pay less). However, grades might serve another purpose. One interpretation is that,
to obtain a stipend, students can pay for grades from any professor. However, professors that otherwise provide higher value can obtain higher payments from the students. Thus, a market has arisen in which the students appear to be paying local professors for grades but are actually paying based on grades and the quality of instruction. (Foreign professors are driven by dedication to helping their ancestors' homeland.) Here the university pays the students (U) for receiving a higher "evaluation" and the students provide a side payment to their evaluators (D). Because the university pays local professors only $100 per month, it is not unreasonable to assume that the university administrators are aware of the local culture.

Lithuanian expatriots report that the system seems to work when there is good reason to believe that the local instructor will be able to honor the "contract." The system breaks down when the instructors leave the university unexpectedly and the students (or their families) have no recourse.

**Formalization**

The above examples illustrate that it is a common situation in marketing for a downstream agent (D) to evaluate an upstream agent (U) and for the upstream agent to be compensated by the firm for higher evaluations. It is also common for the upstream agent to provide a side payment to the downstream agent in exchange for a higher evaluation. We adopt the quality movement's term and call this side payment a "gainshare." We apply this term to the situation we analyze in this paper and thus distinguish our analysis from more general cases of bribery.

We assume two properties that we feel model the essence of the above examples: (1) the evaluation-for-side-payment contract is credible and (2) the firm can anticipate this contract. For example, we assume that when a traveler chooses an airline the traveler expects that the airline will honor its commitment to provide frequent flyer mileage credit and we assume that the firm can anticipate the credit that the traveler will obtain. Similarly, we assume that Lithuanian Ph.D. students can credibly anticipate an improved grade in return for their labor on the professor's summer cottage and we assume that the student-built summer cottage can be anticipated by the university. We are assuming that it is easier to contract on the side payment than it is to contract on the other actions that the upstream agent chooses. That is, we assume the traveler and the airline can contract on frequent flyer credit more easily than they can contract on arrival time or in-flight amenities. We assume that the student and the professor can contract (at least implicitly) on grades for summer-cottage labor
more easily than they can contract on the value of the knowledge that the professor imparts in his or her academic discipline. This issue of observability is often discussed in the press. For example, in commenting upon one hundred deals worth $45 billion in which overseas rivals used bribes to undercut US firms, the vice-president of the Emergency Committee for American Trade stated that one solution is to hold the contracting process up to greater public scrutiny (Borrus 1995).

These assumptions limit our focus to certain types of gainsharing. However, we believe that these types of gainsharing include important marketing issues. We now formalize the above examples recognizing that the formalization is an abstraction that may require some elaboration for specific examples.\footnote{We adopt here the formalization that Hauser, Simester and Wernerfelt (1996) use to analyze internal customers and internal suppliers. We repeat the notation and definitions here so that this article is self-contained.} Table 1 interprets the above examples in light of the definitions below.

\textit{Notation}

We assume that the principal wants to maximize some objective. For some organizations this could be social welfare (universities) or some surrogate for profit (customer satisfaction). The objective, $\pi$, is a function of the actions that the agents put forth. That is, the upstream agent (U) puts forth some action, $u$, and the downstream agent (D) puts forth some action, $d$. For example, if American Airlines provides faster service ($u$) the frequent flyer might be able to take actions ($d$) to serve his or her firm's customers more profitably. We assume that the downstream agent can observe (and evaluate) the upstream agent's actions much better than firm can observe those actions. (The frequent flyer experiences the airlines directly.) Formally, we assume that the firm can not observe $u$ and $d$ directly, but we assume that D can observe $u$.

We assume that $\pi(u,d)$ is thrice differentiable and concave in both arguments. We further allow noise in the firm's ability to reward based on its objective. Call this measure $\tilde{\pi}$ and model the noise as a zero-mean, normal random variable, $e$, such that $\tilde{\pi} = \pi(u,d) + e$.

We assume that the actions are perceived by the agents to be costly. For example, it costs American Airlines more to provide faster service and it is more onerous for the salesperson to serve his or her customer better. The costs for the upstream agent are $c_u(u)$ and the costs for the downstream agent are $c_d(d)$. We assume that these cost functions are thrice differentiable, increasing,
and convex. We define these costs as incremental and normalize them to zero. That is, \( c_u(0) = 0 \) and \( c_d(0) = 0 \). Similarly, we treat \( \pi \) as incremental and normalize \( \pi(u=0,d) = 0 \) and \( \pi(u,d=0) = 0 \).

**Evaluation System**

We assume that, either explicitly or implicitly, the downstream customer evaluates the upstream customer with a rating, \( s \). For example, \( s \) can be an explicit internal customer rating or an implicit rating that the firm infers from a decision made by \( D \). (If IBM pays American Airlines for the amount of travel that \( D \) chooses then \( D \)'s travel portfolio can be regarded as \( s \).) We restrict our attention to continuous reward systems where the firm pays the upstream agent \( v(s) \) and the downstream agent \( w(s,\pi) \). That is, we allow \( D \)'s reward to depend upon the outcome measure that the firm observes. The frequent flyer's rewards might depend upon his or her contribution to the firm's profits or the Lithuanian professor's rewards might depend upon his or her contribution to the social welfare provided by the university.

We examine systems where (1) the firm rewards the upstream customer more if it receives a higher evaluation and (2) the downstream agent may find it costly to provide that higher evaluation. We allow linear functions. For example, the frequent flyer might be penalized for excess travel or the professor might be criticized by peers for giving all "A+"s." Technically, this means we restrict attention to \( v \) and \( w \) that are thrice differentiable and concave in \( s \) and to \( v \) that is increasing in \( s \). We want \( s \) to be an indicator of \( u \)'s effect on \( \pi \), thus we examine \( w \)'s such that \( \partial^2 w / \partial ud \partial s > 0 \).\(^4\)

**The Formal Game**

We formalize the order of actions as follows: (1) The firm acts first and announces a reward system, \( v \) and \( w \). Based on this reward system, (2) the upstream agent acts next to select its actions, \( u \), if by doing so it can do better than not acting. (3) The downstream agent observes these actions, but the firm does not. (4) Next, \( U \) and \( D \) agree on a contract for a gainshare, \( g \), and an evaluation, \( s \). Both do so anticipating what this will imply for \( D \)'s actions, \( d \), and the resulting expected profit,

\(^4\)We also make a technical assumption that \( \partial^2 w / \partial ud \partial s \) is bounded away from zero. This weak assumption simplifies the formal proof. Without it we need a more complicated and less intuitive proof.
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π. If they can not agree on a contract, D takes no actions. (5) D announces the evaluation, s. (6) The upstream agent receives its reward, \( v(s) \), based on this evaluation. (7) The downstream agent, D, acts in its own best interests to choose its action, \( d \). (8) The firm observes its objective, \( \pi \), and (9) pays D its reward, \( w(s, \pi) \).

Naturally, we assume that the firm will announce a reward system only if it can do better with the actions and profits implied by the reward system than it could do in the absence of a reward system. (Without a reward system, the agents set \( u \) and \( d \) to zero.)

Firm’s Goals, Agents’ Goals

We assume that the firm is risk neutral and profit maximizing. Thus, the firm will seek to maximize the expected value of profits minus wages:

\[
\text{expected net profit} = E[\pi(u,d) - v(s) - w(s,\pi)]
\]

We assume that both the upstream and downstream agents are risk averse and will act in their own best interests to maximize expected utility where the utilities, \( U_u \) and \( U_d \), are integrable, thrice differentiable, increasing, and concave. We scale perceived costs so that they are measured on the same scale as profits and wages. (Please note: our mnemonic notation for the upstream agent, \( U \), is distinguished from the notation for utility, \( U \), by the use of italics.) In the absence of a side payment each agent acts to maximize the following expressions.

\[
\begin{align*}
\text{upstream agent maximizes } & E U_u [v(s) - c_u(u)] \\
\text{downstream agent maximizes } & E U_d [w(s,\pi) - c_d(d)]
\end{align*}
\]

The upstream agent acts first by choosing an action, \( u \), that the downstream agent can observe. In the absence of a side payment, the downstream agent will take \( u \) as given and act to maximize the second expression in Equation 2. The downstream agent’s maximization implies three continuously differentiable functions, \( \hat{s}(u) \), \( \hat{d}(u) \), and \( \hat{\pi}(u) \), which tell us how D would react to U’s choice of actions and how expected profit would be affected if there were no side payment.

However, we want to analyze situations that allow U to offer a side payment, \( g \), to D in return for a higher evaluation, \( \hat{s} \). We model this offer as a take it or leave it offer, but we could obtain similar results for other assumptions on how U and D share surplus, if any, from the \((g, \hat{s})\) contract.
D will accept this contract if D can do at least as well by reporting \( s \) in return for receiving \( g \). Thus, D’s expected utility from the contract must be at least as large as that which D can obtain in the absence of a side payment. This constraint defines critical values of \( g(u, s) \) for every action, \( u \), and potential evaluation, \( \hat{s} \). We write \( \dot{d} = \dot{d}(u, \hat{s}) \) for the action that D chooses in order to maximize its own expected utility based on U’s actions and the potential evaluation. We define \( \hat{\pi} = \hat{\pi}(u, \hat{s}) \) for the resulting profits. Formally, the implied constraint is:

\[
EU_d[w(\hat{s}, \hat{\pi}) - c_\hat{d}(\hat{d}) + g(u, \hat{s})] \geq EU_d[w(\hat{s}, \hat{\pi}) - c_d(\dot{d})]
\]

For a given \( v \) and \( w \), the upstream agent will select \( u \) and \( \hat{s} \) to maximize its expected utility recognizing that the choice of \( u \) and \( \hat{s} \) implies \( \dot{d} \) and \( g \) by Equation 3. (U will select \( g \) so that the inequality in Equation 3 is binding.) Thus, if gainsharing is allowed, we modify the first line of Equation 2 to obtain:

\[
EU_u[v(\hat{s}) - c_u(u) - g(u, \hat{s})]
\]

The firm will want to select the functions \( v \) and \( w \) to maximize Equation 1 recognizing that \( v \) and \( w \) will cause U and D to choose \( \hat{u} \), \( \dot{d} \), \( \hat{s} \), and \( \hat{\pi} \) to maximize Equation 4 subject to Equation 3.

However, the firm must assure that neither U nor D refuse to take their actions. Let \( \bar{U}_u \) and \( \bar{U}_d \) be the minimum utilities that U and D require to take non-zero actions. We assume that these utilities represent the expected utility that U and D can obtain from other options that they have available. That is, we assume that \( \bar{U}_u \) and \( \bar{U}_d \) are set by the market. Thus, the firm recognizes that it must select \( v \) and \( w \) such that:

\[
EU_u[v(\hat{s}) - c_u(u) - g(u, \hat{s})] \geq \bar{U}_u
\]

\[
EU_d[w(\hat{s}, \hat{\pi}) - c_d(\dot{d}) + g(u, \hat{s})] \geq \bar{U}_d
\]

Because the firm is maximizing expected profits, it will select \( v \) and \( w \) such that the constraints implied by Equation 5 are binding.

Thus, in principle, for any choice of \( v \) and \( w \), we can optimize Equation 1, subject to the constraints imposed by Equations 3, 4, and 5. This optimization implies \( \hat{u} \), \( \dot{d} \), and \( \hat{\pi} \) as well as the intermediate variables \( \hat{s} \), \( s \), \( \dot{d} \), \( \hat{\pi} \), and \( g \). Our technical assumptions assure that these solutions exist.
Gainsharing Almost Always Occurs

The upstream/downstream structure of our formalization almost always guarantees gainsharing. By this we mean that there are economic incentives for gainsharing. We do not model situations where there is an exogenous fixed cost to gainsharing such as the potential of a reprimand (or worse) for any perceived impropriety. Naturally, such fixed costs could mitigate the economic incentives.

Interior Solutions

The intuition is best seen in the case where \( v \) and \( w \) imply interior solutions. In this case, in the absence of a side payment, \( D \) will maximize the right hand side of equation 3 by setting the derivatives to zero. That is,

\[ \frac{\partial E_{d}[w(s) - c_d(\hat{d})]}{\partial \hat{s}} = 0 \]

Thus, the marginal loss to \( D \) of an very small increase in \( s \) is zero. On the other hand, because \( U_u \) is increasing in \( v \) and \( v \) is increasing in \( s \), \( U \) gains by having \( D \) increase \( s \). That is,

\[ \frac{\partial E_{u}[v(s) - c_u(u)]}{\partial \hat{s}} > 0 \]

Thus, intuitively there appear to be gains to trade at \( \hat{s} \) -- \( U \) gains more than \( D \) loses.

The actual proof is more complex because we have to account for the integration implied by the expected utility operators, but the basic intuition does not change. (A formal proof is given in an appendix that is available from the authors.) For any \( v \) and \( w \) chosen by the firm such that (1) the firm makes positive profits, (2) \( U \) and \( D \) find it better to take some actions than to take no actions, and (3) the \( v \) and \( w \) imply interior solutions, then there are economic incentives to gainshare.
Constraints

For some \( v \) and \( w \), \( U \) will find that the optimal solution to Equation 3 (RHS) or Equation 4 is a boundary solution. For example, suppose that \( s \) is constrained to be less than some upper bound, \( \bar{s} \), and this upper bound is less than that which \( D \) would otherwise choose. Then \( D \) might find it to be in its best interest to set \( s = \bar{s} \). This might replace the equality in equation 6 with an inequality and there may be no gains to trade.

These are realistic situations. Grades may be limited to A+ or customer satisfaction ratings may be limited to the top box of a 7-point scale. In these situations there may be no gainsharing because \( U \) can choose \( u \) such that \( D \) reports \( s = \bar{s} \) without a gainshare. For example, some travelers might choose American Airlines even if there were no frequent flyer credits.

However, constraints do not rule out gainsharing. Some realistic \( v \) and \( w \) imply conditions such that, in the absence of a gainshare, the best response by \( U \) and \( D \) is no action. In these situations, the firm might get non-zero actions and profits only if gainsharing is allowed. For example, with a specific \( v \) and \( w \) the traveler may only hit the road if he or she gets frequent flyer credits. Hauser, Simester, and Wernerfelt (1996) demonstrate a system in which the linearity of \( v \) and \( w \) cause \( U \) to provide \( D \) with a gainshare in return for reporting \( s = \bar{s} \).

No Room to Trade

There is a final situation we must consider. Suppose \( v \) increases at a slower rate than \( w \) decreases. If this happens over the entire range, there will never be any \( s \) where there are gains to trade. However, such a situation will not occur for a rational firm. If \( v \) increases at a slower rate than \( w \) decreases, then the optimal response for \( D \) is to set \( s = 0 \). However, this means that \( U \) will set \( u = 0 \) because any actions incur costs without rewards. This will, in turn, cause \( D \) to set \( d = 0 \) and the firm will earn only as much with the reward system in place as it did without the reward system in place. This violates one of our assumptions.

This covers all the cases for continuous \( v \) and \( w \). In an appendix we prove formally that:

**RESULT 1.** For incentive systems in which the rewards to the upstream agent are increasing in the downstream agent's evaluation, the upstream agent will provide a positive side payment to the downstream agent unless the firm sets a binding upper bound on the evaluation (or otherwise precludes side payments). Even with a binding upper bound, there may be gainsharing.
Gainsharing Need Not Hurt the Firm’s Profits

Consider the following hypothetical situation. UD industries owns its own fleet of corporate jets and these jets are used by the executive salesforce to sell big-ticket capital equipment around the world. Let’s assume that we can treat the corporate-jet division (U) as one agent and the salesforce division (D) as another agent. (There will be free-riding issues within each division, but we will ignore these for the purposes of this illustration.) In some general way (but with concave functions) the corporate-jet division gets greater rewards if the salesforce uses its jets for transportation. The salesforce division is rewarded for making profitable sales ($\pi$) but is charged for its use of the corporate jets. If $s$ signals the amount of corporate-jet travel that the salesforce division chooses, then we can see that $w$ is downward sloping in $s$ and $v$ is increasing in $s$. Finally, let’s assume that the executive salespeople value personal (non-business) travel by corporate jet -- at least as much as it costs U to provide this service.

Suppose now that the corporate-jet division announces that it will provide frequent flyer credits to the salesforce division and that the salesforce division can use these credits for their own personal use. This is a public announcement and the firm is aware of the details of the frequent flyer program. This may be efficient from the firm’s standpoint because it can increase D’s utility at least as much with frequent flyer credits as it can with monetary rewards. If the firm can anticipate the value of the frequent flyer credit ($g$) that D will receive, it can decrease D’s rewards by $g$ and still satisfy the constraint in the second line of Equation 5. However, it must somehow compensate U for providing the frequent flyer credit so that the first line of Equation 5 is not violated.

There are at least two ways for the firm to increase U’s compensation. First, it might simply increase U’s fixed rewards by $g$. Alternatively, it might modify $v$ so that, in equilibrium, U’s choice of actions implies a $v(s)$ that reimburses U for the frequent flyer credit. Because U’s actions and effort in providing the frequent flyer credit are difficult for the firm to observe, this reward-for-rating system might be more efficient. To keep profits the same, the firm might use $w$ to decrease D’s rewards to offset the benefit of the frequent flyer program to D.

This example demonstrates the basic intuition of this section. If the firm can anticipate the actions of U and D, it can use $v$ to increase U’s compensation by an amount equal to $g$ and use $w$ to lower D’s compensation by an amount equal to $g$. If it can do this in such a way that the U and D choose the same actions, $\hat{u}$ and $\hat{d}$, under the new reward system with gainsharing as U and D chose
under the old reward system without gainsharing, and if the new reward system does not impose any new risks on U and D, then the firm can earn the same profits. (The firm earns $\pi(\hat{u}, \hat{d})$ before paying wages, the same as without gainsharing. If the only change in $w$ is to subtract a function of $s$, then the firm does not have to reimburse for new risks -- the only change in the wages is that the firm pays U more and D less by the amount $g$.) In the appendix (available from the authors) we prove:

**RESULT 2.** If the firm can preclude gainsharing and design a reward system, $v$ and $w$, such that the upstream and downstream agents, acting in their own best interests, choose actions $u^o$ and $d^o$, then, without any loss of profits, the firm can design a reward system such that the upstream and downstream agents, still acting in their own best interests, choose $u^o$ and $d^o$ even though they are free to share gains.

The basic proof follows the intuition of the frequent flyer example. The modified reward system changes the slope of $v$ with respect to $s$ to achieve the new equilibrium $\hat{s}$ implied by gainsharing. The change in slope offsets the cost to U of $g$. The firm reduces D's rewards by $v^o(s^o) - v(s)$. This causes D to prefer the new $\hat{s}$ while maintaining equality in Equation 5. Together these changes do not affect the first-order conditions for $u$ and $d$ nor do they add any risk. (Recall that $s$ and $g$ are anticipated and do not depend upon the noise, $e$.)

Result 2 does not guarantee that a reward system can be found to maximize firm profits (with or without risk). However, Result 2 does guarantee that if such a no-gainshare system can be found, then the firm can also maximize profits with a gainsharing system. That is, gainsharing systems do at least as well as non-gainsharing systems.

There might be situations where a gainsharing system is attractive to the firm. For example, frequent flyer credits may help airlines smooth demand by encouraging flyers (1) to travel when flights are not at capacity and (2) to upgrade to first-class seats that would otherwise be empty. It may be less costly to the firm to allow its "road warriors" to be compensated in this way than it would be to increase their monetary pay. This is, of course, an empirical question.\(^5\) (TWA estimates the average cost of a frequent flyer trip award to be $28, considerably less than the traveler would pay for a comparable flight. The current US tax code does not tax this benefit [Peterson 1996]).

\(^5\)The *Wall Street Journal* (9/29/1995) states "One of the most widely bestowed favors by U.S. companies is the foreign trip (to Chinese decision makers)."
Gainsharing systems might also be attractive because they coordinate U and D and, especially, make U’s rewards sensitive to D’s costs. To see this notice that U maximizes Equation 4 which is linked directly to D’s costs in Equation 3 because $g(u,s)$ appears in both equations. This link is less direct in Equation 2.

Summary

Gainsharing is common. Our formal analysis suggests that this should not be surprising because (1) the structure of many upstream-downstream incentive systems often guarantees that there are economic incentives to gainshare and (2) if the firm can anticipate this gainsharing then it can always factor it into the compensation system with no loss of profits. Gainsharing may not occur if $s$ is constrained (Result 1) or if the firm or society uses peer pressure, cultural norms, or punishment to prevent gainsharing.

Our analyses are limited to situations where gainsharing is public knowledge. There are many research opportunities for studying other types of side payments in marketing. If the $(g,s)$ contract is not enforceable, then the system may break down or there might be additional risk-related costs imposed on the system. For example, if a Lithuanian student’s family can not be sure that the professor will be around next semester, then they may take the uncertainty in $s$ into account. Future research might model this uncertainty or the implications of any information asymmetries that degrade the ability to anticipate $g$. Other research might investigate whether situations exist such that the firm can do better by allowing gainsharing than it can by precluding gainsharing. (For example, the firm may be able to implement some actions, $u$ and $d$, with a gainsharing system that it could not implement with a no-gainshare system. Finally, there are a wealth of empirical research opportunities to study the $v$ and $w$ functions that occur in practice. With sufficient empirical experience we might improve both the descriptive and prescriptive aspects of the theory.
REFERENCES


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Table 1. Summary of Six Examples
Appendix: Formal Proofs

RESULT 1. For incentive systems in which the rewards to the upstream agent are increasing in the downstream agent’s evaluation, the upstream agent will provide a positive gainshare to the downstream agent unless the firm sets a binding upper bound on the evaluation (or otherwise precludes side payments). Even with a binding upper bound, there may be gainsharing.

Proof. Consider a given \( u \). Let \( f(e) \) be the density function for \( e \). Consider first the case where there is no upper bound on \( s \) or it is not binding. \( U \) will seek to maximize the expression in Equation 4 subject to the conditions imposed by \( D \)’s maximization problems in Equation 3. Let \( \Gamma_u = v - c_u - g \). Differentiating Equation 4 we obtain:

\[
\int_{-\infty}^{\infty} \frac{\partial U_u}{\partial \Gamma_u} \frac{\partial [v(s) - c_u(u) - g(u,s)]}{\partial s} f(e) \, de = 0
\]

By assumption, \( \partial U_u/\partial \Gamma_u > 0 \). The error, \( e \), appears in \( w \), but it does not appear in \( v \), \( c_u \), or \( g \). Thus, this integral can be zero if and only if \( \partial U_u/v - c_u - g / \partial s = 0 \). Thus, this first order condition holds if only if:

\[
(A1) \quad \frac{\partial v(s)}{\partial s} - \frac{\partial g(u,s)}{\partial s} = 0
\]

Let \( \Gamma_d = w - c_d + g \). We now use implicit differentiation on Equation 3 recognizing that the right-hand side (RHS) does not depend on \( \dot{s} \).

\[
(A2) \quad \int_{-\infty}^{\infty} \frac{\partial U_d}{\partial \Gamma_d} \frac{\partial w(s, \pi)}{\partial \dot{s}} + \frac{\partial \Gamma_d}{\partial g} \frac{\partial g(u,s)}{\partial s} f(e) \, de = 0
\]

By assumption \( \partial U_d / \partial \Gamma_d \), which depends on \( e \), is positive. Furthermore, \( g(u, \dot{s}) \) does not depend upon \( \dot{s} \), and \( \partial \Gamma_d / \partial w = \partial \Gamma_d / \partial g = 1 \). Hence, Equation A2 becomes:

\[
(A3) \quad \int_{-\infty}^{\infty} \frac{\partial U_d}{\partial \Gamma_d} \frac{\partial w(s, \pi)}{\partial \dot{s}} f(e) \, de = - \frac{\partial g(u,s)}{\partial s} \int_{-\infty}^{\infty} \frac{\partial U_d}{\partial \Gamma_d} f(e) \, de
\]

From A1 we have \( \partial g(s,u) / \partial s = \partial v(s) / \partial s \). But \( \partial v(s) / \partial s > 0 \) by assumption. Thus, the RHS of A3 is negative:

\[
(A4) \quad \int_{-\infty}^{\infty} \frac{\partial U_d}{\partial \Gamma_d} \frac{\partial w(s, \pi)}{\partial \dot{s}} f(e) \, de < 0
\]

By similar arguments we use implicit differentiation on Equation 3 to obtain:

\[
(A5) \quad \int_{-\infty}^{\infty} \frac{\partial U_d}{\partial \Gamma_d} \frac{\partial w(s, \pi)}{\partial \dot{s}} f(e) \, de = 0
\]

Finally, we differentiate the left-hand side (LHS) of A4 or A5 to demonstrate that the second derivative with respect to \( s \) is negative (concave) because \( \partial U_d / \partial \Gamma_d > 0 \) and \( \partial^2 w / \partial s^2 < 0 \). Thus, we have shown that the first derivative of a concave function is negative at \( \dot{s} \) and zero at \( s \). Hence, \( \dot{s} > s \). The gainshare is positive by Equation 3. In the case where \( s \) is constrained, we add a Lagrange multiplier, \( -\lambda(s - s_{max}) \), to \( U \)’s
optimization problem. This might allow a solution of the form $\frac{\partial v}{\partial s} = \lambda$ and $\frac{\partial g}{\partial s} = 0$. If $u$ were limited to a finite set, we obtain a result similar to that for Lagrange multipliers by using a series of piecewise functions for $w$ such that each piece corresponds to a different action by $U$. Finally, the reader can verify gainsharing for $v = v_e + v_f s$ and $w = w_e + w_f (1 - s) + w_f s t^A$ for $s \in [0, 1]$ and sufficiently large $v_e$ and $w_e$.

RESULT 2. If the firm can preclude gainsharing and design a reward system, $v$ and $w$, such that the upstream and downstream agents, acting in their own best interests, choose actions $u^*$ and $d^*$, then, without any loss of profits, the firm can design a reward system such that the upstream and downstream agents, still acting in their own best interests, choose $u^*$ and $d^*$ even though they are free to share gains.

Proof. We prove the theorem for any implementable actions, $u^*$ and $d^*$. We begin with interior solutions for $s$. Let $v^*(s)$ and $w^*(s, \pi^*)$ implement $u^*$ and $d^*$ without gainsharing. ($v^e, c^e$ are shorthand for $v^*(u^*, d^*)$ and $c^e(d^*)$, respectively. Define $\Gamma_d^* = w^*(s, \pi^*) - c^e(d^*)$ and $\Gamma_u^* = v^*(s) - c^e(u^*)$.) Then $s^*, u^*$, and $d^*$ satisfy the following first order conditions.

\[
\frac{\partial E_d}{\partial s} = \int \left[ \frac{w^v(s^*, \pi^*)}{\partial s} \right] f(e) de = 0
\]

\[
\frac{\partial E_u}{\partial d} = \int \left[ \frac{w^u(s^*, \pi^*)}{\partial d} \frac{\partial g_u(u^*, d^*)}{\partial d} - \frac{\partial c_d(d^*)}{\partial d} \right] f(e) de = 0
\]

\[
\frac{\partial E_u}{\partial u} = \int \left[ \frac{w^v(s^*, \pi^*)}{\partial u} \frac{\partial c_u(u^*)}{\partial u} + \frac{\partial c_d(d^*)}{\partial d} \right] f(e) de = 0
\]

At this point we could continue to track through all the integral expectations as we did in the proof to Result 1. However, this notational nightmare adds no new insight to the basic proof. (Our proof demonstrates that two sets of first-order conditions lead to the same $u^*$ and $d^*$. With the integrals, these first-order conditions are still equal. We also refer the reader to Wernerfelt, Simester, and Hauser 1996 who provide a proof with the integrals, but for the special case when $D$ is a pure supervisor and takes no actions, $d$, to affect outcomes, $\pi$.) Thus we work with the terms in the brackets and leave it to the interested reader to maintain the integrals throughout. This would be exact if the error, $e$, were additive to $w$ rather than to $\pi$. Since $\partial \Gamma_u / \partial w = -\partial \Gamma_u / \partial c_e = \partial \Gamma_u / \partial v = -\partial \Gamma_u / \partial c_e = 1$, the simplified first-order conditions reduce to:

\[
\frac{\partial w^v(s^*, \pi^*)}{\partial s} = 0
\]

\[
\frac{\partial w^u(s^*, \pi^*)}{\partial \pi} \frac{\partial \pi(u^*, d^*)}{\partial d} - \frac{\partial c_d(d^*)}{\partial d} = 0
\]

\[
\frac{\partial v^v(s^*)}{\partial s} \frac{\partial c_e(u^*)}{\partial u} = 0
\]

Now allow gainsharing and select new reward functions, $w(s, \pi) = w^v(s, \pi) - \alpha s + v^v(s^*)$ and $v(s) = \alpha s$. Recall that the firm must reimburse $U$ and $D$ for their risk costs because $\pi$ contains noise and both $U$ and
D are risk averse. Under the specified reward system (for no gainsharing) only D incurs risk due to \( w'(s, \pi) \). Because the noise does not affect \( s \), the only risk that D will incur under the new reward system is still due to \( w'(s, \pi) \). Thus, if the new reward system implements \( v', d', s' \), then the cost of risk will be the same for D and hence for the firm which must reimburse D for that risk. Now, we must only prove that an \( \alpha \) can be chosen such that the new reward functions implement \( u', d', \) and \( s' \) when gainsharing is allowed.

For a given \( u' \), without a gainshare, D would maximize the RHS of Equation 3. After simplification similar to that used to derive Equations A6-A8, \( d(u') \) and \( \dot{s}(u') \) are defined by the following. (\( \pi \) is shorthand for \( \pi(u', d') \)).

\[
\frac{\partial w'(s, \pi)}{\partial s} - \alpha = 0
\]
\[
\frac{\partial w'(s, \pi)}{\partial \pi} \frac{\partial \pi(u', d)}{\partial d} - \frac{\partial c_d(d)}{\partial d} = 0
\]

For a given \( u' \), with a gainshare contract \( (g, \dot{s}) \), D will choose \( \dot{d} \) to maximize the LHS of Equation 3. After simplifying we obtain (\( \pi \) is shorthand for \( \pi(u', \dot{d}) \)).

\[
\frac{\partial w'(s, \pi)}{\partial \pi} \frac{\partial \pi(u', \dot{d})}{\partial \dot{d}} - \frac{\partial c_d(\dot{d})}{\partial \dot{d}} = 0
\]

If \( \dot{u} = u' \) and \( \dot{s} = s' \), then Equation A11 is the same as Equation A7 implying \( \dot{d} = d' \).

Now U chooses \( \dot{s}, \dot{u}, \) and \( g \) to maximize Equation 4 subject to Equation 3. Use the definition of \( \Gamma_d \) and \( \Gamma_u \) from the proof to Result 1. We first differentiate Equation 4 and simplify (review A1).

\[
\alpha - \frac{\partial g}{\partial s} = 0
\]
\[
- \frac{\partial c_u(\dot{u})}{\partial u} - \frac{\partial g}{\partial u} = 0
\]

We use implicit differentiation on Equation 3. (U will choose \( g \) such that Equation 3 is binding. The RHS is not a function of \( \dot{s} \).) After simplification (review A2-A3):

\[
\frac{\partial w'(s, \pi)}{\partial s} - \alpha + \frac{\partial g}{\partial s} = 0
\]

Substituting Equation A12 into Equation A14 yields Equation A4 thus if \( \dot{u} = u' \), then \( \dot{s} = s' \) because \( \dot{d} = d' \) whenever \( \dot{u} = u' \) and \( \dot{s} = s' \). We must now show that we can choose \( \alpha \) such that \( \dot{u} = u' \).

We begin by implicitly differentiating Equation 3 with respect to \( u \). After extensive simplification this becomes Equation A15. (We use the first-order conditions in Equations A7, A9, and A14 to eliminate many terms by the envelop theorem and we use Equation A13 to substitute \( \frac{\partial g}{\partial u} = -\frac{\partial c_u(\dot{u})}{\partial \dot{u}} \).)

We must now demonstrate that we can choose an \( \alpha \) such Equation A15 holds when the participation constraints hold. (We first replace \( v'(s') \) with \( K(\alpha) \) such that the participation constraints hold.) Let us fix \( \dot{u} = u' \) and \( \dot{s} = s' \), then only the RHS of equation A15 varies as \( \alpha \) varies. First consider \( \alpha = 0 \). When
\[ \alpha = 0, \ u = u^*, \text{ and } \hat{s} = s^* \text{ by Equations A9 and A10 which become the same as A6 and A7. Because the participation constraints hold, } \Gamma_d = \Gamma_d, \text{ thus the term on the RHS of equation A15 is the same as the first term on the LHS of Equation A15. Since } \partial U_d/\partial \gamma > 0 \text{ and } \partial c_u/\partial u > 0, \text{ this implies that for Equation A15 we have LHS < RHS.} \]

Continue to fix \( u = u^* \) and \( \hat{s} = s^* \) and let \( \alpha \to \infty \). We use the implicit function theorem on Equations A9 and A10 (differentiating with respect to \( \alpha \)) to obtain:

\[ (A16) \quad \left( \frac{\partial^2 \hat{w}^o}{\partial s^2} + \frac{\partial \pi}{\partial \pi} \left( \frac{\partial^2 \hat{w}^o}{\partial \pi^2} \right) \right) \left[ \frac{\partial^2 \hat{w}^o}{\partial \pi^2} \left( \frac{\partial^2 \hat{k}}{\partial d^2} \right) + \frac{\partial \hat{w}^o}{\partial \pi} \frac{\partial^2 \hat{k}}{\partial d^2} - \frac{\partial^2 \hat{e}_d}{\partial d^2} \right] \frac{\partial \pi}{\partial \alpha} = 1 \]

By the assumptions of the text, the term in the large brackets, \( \{ \} \), is negative, thus \( \hat{s} \to \infty \) as \( \alpha \to \infty \). Then, because \( \partial /\partial s \hat{w} /\partial \pi /\partial s \) is bounded from zero, we have \( \hat{w} (s, \pi) /\partial \pi \to \infty \). Hence, for \( \alpha \to \infty \) in Equation A15 we have LHS > RHS. Finally, Equations A9 and A10 tell us that the change with respect to \( \alpha \) is continuous, thus there must be an \( \alpha \) between 0 and \( \infty \) such that for Equation A15 LHS = RHS for \( u = u^* \).

To summarize, we have proven that an \( \alpha > 0 \) exists such that Equation A15 is satisfied. Thus, \( \hat{u}, \ d, \) and \( \hat{s} \) must satisfy Equations A6-A8 hence \( \hat{u} = u^*, \ d = d^*, \hat{s} = s^* \) for \( w(s, \pi) = w^o(s, \pi) - \alpha s + \nu^o(s^*) \), and gainsharing is allowed. The proof for constrained \( s \) requires that we introduce Lagrange multipliers in Equations A6, A8, A9, A12, and A14. This does not affect the arguments for \( \hat{s} = s^* \) and \( d = d^* \). We then use the new A9 and A14 to simplify for Equation A15 and the rest of the proof follows. \( \blacksquare \)