

In-Kind Payments as a Compensation Strategy*

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Abstract

In this paper, we offer a new explanation for the use of non-cash compensation by firms. We show that employee discounts allow firms to practice price discrimination between employees and non-employees in a value enhancing manner. In particular, the optimal price discriminating employment contract offers a firm's product at a lower price to the firm's employees than to outside consumers. We also characterize optimal bundling of cash and on the job perks and show that the firm can use the perks to extract information rent from employees with private information about their preferences and reservation utility. The level of perks in the optimal employment contract can be lower or higher than the socially efficient level. Thus, in our model overinvestment in managerial perks is a profit-maximizing strategy, rather than a consequence of agency problems.

JEL Classification: J3, L2.

Key Words: In Kind Compensation, Fringe Benefits, Price Discrimination, Wage Discrimination

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1. Introduction

Non-wage forms of employee compensation are pervasive in the corporate world, and they account for a large share of overall payroll. In a 1999 nationwide survey conducted by the United States Department of Commerce, employee benefits constituted greater than one-third of company payrolls, and the average non-wage expenditure per employee was \$14,060 (of this average, one-fifth represents medical insurance premiums and one-third represents paid time off).¹ Non-wage benefits can be grouped into two categories, the first being employee discounts on the goods and services sold by the firm and the second category being in-kind payments. In-kind payments include, but are not limited to health, accident and life insurance payments, paid time off, contributions to retirement plans, educational assistance, meals, lodging, dependent care assistance, property or services provided by the employer, moving expenses, transportation and parking subsidies, the use of an automobile, the use of housing and housing subsidies, and athletic facilities. To this set of fringe benefits, one should add in-kind amenities such as desirable offices, pleasant work environments, and other more intangible forms of compensation.

A key explanation for the use of employee discounts and in-kind payments is that many of these are not fully taxable to the employee or the tax is deferred, while the expenses are deductible by the firm. Given that the firm must meet a participation constraint for a worker, and in-kind payments substitute for cash for the employee, it is cheaper to offer nontaxable payments. However, not all of the existing non-cash payments are tax free and some predate meaningful Federal and State taxes.² Apart from the tax advantage, other explanations that have been offered to explain the prevalence and the level of non-cash compensation include economies of scale, the positive effects of complementary consumption on the productivity of workers, worker-firm commitment, the

¹U.S. Chamber of Commerce (1999).

²See U.S. Internal Revenue Service (2003) and note that, particularly in the natural resource extraction industry, some such benefits predate tax benefits.

positive effects of intertemporal consistency induced by mandatory consumption of pension plans, and agency considerations.³ In this paper we investigate an alternative explanation for employee discounts and in-kind compensation. We hypothesize that non-cash compensation allows firms to practice price discrimination between employees and non-employees, as well as wage discrimination between employees with different preferences and outside opportunities. Our goal is to examine the elemental benefits and costs of employee discounts and in-kind compensation from this specific point of view.

We begin with an analysis of employee discounts and we ask, in the absence of arbitrage, whether it would be optimal for a firm to offer its employees the firm's product at a price below market price. The model allows for heterogeneous consumers from which the firm must select its employee, but the firm can not observe potential worker type. We find that it is, indeed, optimal (value enhancing) for the firm to give employee discounts. The optimal pricing scheme requires that employees be sold the product at the firm's marginal cost and that prices charged to non-employees be higher than marginal cost and higher than in the case where no discounts are offered. Further, we show that the employment contract is optimally designed to induce those who have a greater preference for the firm's product to self select into that contract. Thus, the firm practices a form of price discrimination between employees and non-employees and its profit-maximizing hiring strategy is to hire those who like the firm's product the most.

Next, we consider in-kind compensation (perks) in a model where the firm faces a limited pool of potential employees, so that it cannot be sure that a particular employee type self selects into the offered employment contract. We assume that the firm's potential employees differ according to both their alternative employment options (their reservation utilities) and their preferences for in-kind benefits. We first investigate the case where the firm cannot issue the in-kind commodity

³See Rosen (2000) for a discussion of these explanations.

in a discriminatory manner and, instead, offers a uniform benefit across all employees. Uniformity is descriptive of situations where the benefit has public good properties or where the firm must invest in the in-kind good before hiring a particular worker. We show that, in this case, the profit maximizing firm will bundle cash and perks in order to indirectly wage discriminate among heterogeneous workers, and that, in the optimal bundle, perks are typically issued in a socially inefficient way. For some parameter values, the amount of the perk issued by the firm is too large, for other parameter values, it is too low. More specifically, our results suggest that the amount of in kind compensation that the firm uses depends (i) upon the perk's marginal acquisition cost, and (ii) upon the correlation between the difference in the workers' reservation utilities and a measure of the divergence in the values that the workers place on the perk that the firm provides. In particular, in situations where this correlation is negative, the firm always under invests in the provision of perks. On the other hand, when workers with higher reservation utility (say, more productive workers) also have higher valuation for the perk, the firm provides a lower than efficient quantity of the perk if the perk's marginal cost is low, but it provides an inefficiently large quantity if the perk's marginal cost is high.

Finally, we extend the above analysis of the firm's optimal in-kind compensation strategy to allow for the possibility that the firm can offer each worker a menu of in kind payments/cash compensation bundles and let the workers select their preferred compensation bundle. We show that similar results to the uniform case continue to hold in this alternative setting. That is, firms will continue to wage discriminate among different types of workers (even more effectively than when they have to offer a single contract to all potential employees) and the firm will again over or under invest in perks, depending upon the difference in the workers' reservation utilities, the difference in the values they place on the perk and the perk's marginal cost. Generally, those with low preference for the perk are weakly under supplied and those with high preference are over

supplied. The main difference compared with the case of a uniform benefit is that if marginal cost is intermediate, full efficiency in benefit provision is achieved at optimum.

The possibility of oversupply of in-kind compensation is of particular interest, because it can shed some light on the much controversial issue of perks that firms provide to their top managers. According to the prevalent view in both the academic literature and the popular press, executive perks (like plush offices, lavish retirement packages, corporate jets, and so on) are frequently considered to be excessive compared to the firms' profit-maximizing levels. Following Jensen and Meckling's (1976) seminal paper, the academic literature views the excessive level of managerial perks as a demonstration of agency problems that accompany the separation of ownership and control. While we certainly believe that in some cases managers clearly misuse their positions to extract lavish perks, our model offers an interesting alternative interpretation of the problem. Because (as suggested by casual empiricism) the managerial perks that attract attention are typically of relatively high marginal cost, our theory predicts that it may in fact be in a firm's best interest to provide an excessive level of managerial perks, because this is the level that allows the firm to wage-discriminate between its employees in the most effective way. Moreover, our theory offers a potentially testable implication: The perks that are apparently oversupplied should have relatively higher marginal costs than those that seem to be provided at efficient (or lower than efficient) levels.

Related academic literature on in-kind compensation has not focused on the specific issues considered here. Rosen (2000) nicely summarizes the main existing arguments (mentioned earlier) for the use of non-cash compensation. Prendergast and Stole (1999) consider the related question of why it is that firms generally discourage monetary exchange between employees and promote trades involving barter or the trading of favors. Their argument rests on two reasons why nonmonetary trade may be preferred. Nonmonetary trade can affect the allocation of rents in ways that increase surplus, because agents react strategically to these rents. Also, they show that such trade improves

the ability of agents to impose sanctions on traders who act dishonestly. Much of the remaining literature concentrates on the public policy regulating pay and benefits and the effects that this policy has on the supply of labor and the firm's provision of pay, benefits and the other strategy variables regarding the payment and the hiring of employees. For example, Lazear (1990) studies the effects of severance pay requirements on employment in European countries and finds that they tend to reduce employment. Other papers representative of this literature include Woodbury (1983), Rosen (1986), and Hashimoto (2000). Finally, as will become apparent later, the logic of our results makes our work related to the literature on price discrimination, for example Oi (1971) and Mussa and Rosen (1978), and the literature on commodity bundling, where the classical contributions are by Adams and Yellen (1976) and McAfee and McMillan (1989).

The paper is organized as in the following description. Section 2 analyzes employee discounts and hiring strategy with discounts when the pool of job applicants is large. Section 3 discusses how in-kind compensation can be used by firms to wage discriminate between different types of employees when the pool of qualified job applicants is relatively small. We analyze here both the uniform contract case, as well as the case of a menu of contracts. Section 4 concludes. All proofs are provided in the Appendix.

2. Employee discounts as a price discrimination device

Consider a firm with downward sloping demand that has the option to price differentially between the employee-consumer and the non-employee consumers. The firm hires an employee from a set of heterogeneous agents, where one group of agents likes the monopolist's product more than the other group. Potential employees have alternative employment opportunities with salary \bar{s} . It is assumed that the firm is able to give employee discounts, because it is not possible for the worker to resell the product to non-employees. We are interested in the firm's optimal hiring policy and

its optimal pricing strategy with respect to both employees and non-employees.

In particular, suppose that the firm faces a pool of potential employees and consumers, that consists of two groups. The first group contains $N_1 > 1$ agents of type 1, whose utility from consuming q units of the firm's good is given by the function $u_1(q) + H$; the second group has $N_2 > 1$ agents of type 2, with utility function $u_2(q) + H$, where q is the quantity of the firm's product consumed by an agent and H is a numeraire good representing expenditure on all other goods. The type-1 agents are assumed to like the good more than the type-2 agents. Specifically, $u_1(\cdot)$ and $u_2(\cdot)$ satisfy the following restrictions.

ASSUMPTION 1.

- a) $u_i(0) = 0$, $u'_i > 0$, $u''_i < 0$, and $u'_i(0) = \infty$, $i = 1, 2$.
- b) $\frac{d}{dq_i}[q_i u'_i(q_i)] < 0$.
- c) $u'_1(q) > u'_2(q)$ for each q .
- d) $u''_1(q) < u''_2(q)$ for each q .

Assumption 1a) says that marginal utility of q is positive and diminishing and that zero utility is derived from zero consumption. Part b) leads to a downward sloping demand. Assumption 1c) is the Spence-Mirrlees sorting condition; it says that the marginal utility from the good is always greater for the type-1 agents than for the type-2 agents. Note that part a) taken with part c) imply that $u_1(q) > u_2(q)$ for all $q > 0$. Further, a) and c) imply that the marginal utility of both types of consumers is arbitrarily large for small consumption, which is the standard assumption to ensure interior solutions. According to part d), the marginal utility of type-1 agents decreases more slowly than the marginal utility of type-2 agents. This part will only be used in the current section and will be dispensed with in the next section.

The firm's cost of producing output x is given by $c(x)$. We assume that $c(\cdot)$ is increasing and convex.

ASSUMPTION 2. $c(0) = 0$, $c'(0) < \infty$, and $c', c'' \geq 0$.

The agents are endowed with a fixed income given by I (which will be suppressed in the analysis) and, if employed by the firm, they receive a salary s . The firm can only hire one worker, say type i , who produces the amount x . Utility maximization subject to the relevant budget constraint implies that an agent i 's demand for the firm's product is given by

$$p = u'_i(q_i) \equiv p_i(q_i), \quad i = 1, 2.$$

When making its hiring decision, the firm is not able to distinguish between the two types of workers. In this section, however, the pool of potential employees is assumed to be large, so that the firm can always be sure that the desired type of worker self selects into the offered contract. This assumption will be relaxed in the next section. The firm sells the good to both the employee and the outsiders (non-employees), potentially charging a different price to the employee than to the outsiders. Let $p_i(q_i^w)$ be the inverse demand function of worker whose type is i and $p_j(q_j^o)$ the inverse demand function of an outsider whose type is j , $i, j \in \{1, 2\}$. The firm's problem is to choose the type of worker, $i = 1$ or $i = 2$, salary s , and the three quantities, q_i^w , q_1^o and q_2^o , so as to maximize its profit:

$$\max_{\{i, s, q_i^w, q_i^o, q_j^o\}} q_i^o p_i(q_i^o)(N_i - 1) + q_j^o p_j(q_j^o)N_j + q_i^w p_i(q_i^w) - c(x_i) - s, \quad (1)$$

subject to

$$s + u_i(q_i^w) - q_i^w p_i(q_i^w) \geq \bar{s} + u_i(q_i^o) - q_i^o p_i(q_i^o), \quad (2)$$

$$s + u_j(q_j^w) - q_j^w p_j(q_j^w) < \bar{s} + u_j(q_j^o) - q_j^o p_j(q_j^o), \quad (3)$$

$$x = q_i^o(N_i - 1) + q_j^o N_j + q_i^w, \quad (4)$$

and

$$p_i(q_i^o) = p_j(q_j^o). \quad (5)$$

Constraints (2) and (3) are the worker's participation and self-selection constraints. Constraint (2) ensures that a worker i 's utility from being employed by the company at the salary s and paying the insider's price of p_i^w for the good is at least as high as getting the alternative employment salary \bar{s} and paying the outsider price $p_i(q_i^o)$. Constraint (3) guarantees that type- j agents do not seek employment with the company, because they are better off getting the alternative salary \bar{s} and buying the good at price $p_j(q_j^o)$. According to constraint (4), the firm cannot sell more than it produces. Finally, constraint (5) says that the price charged to the two types of outsiders must be the same, because the firm is not able to distinguish between them.⁴ Let p^{o*} and p^{w*} denote the profit-maximizing prices charged by the firm to outsiders and to the worker respectively, and let x^* be the firm's profit-maximizing level of output.

Proposition 1. *Suppose that the pool of potential employees is large, so that the firm's desired employee type is always available. The firm's optimal hiring and pricing strategy is then characterized by (i) - (iii) below.*

⁴In a more complicated model, the firm would be able to price discriminate between the two different types of outside consumers, for example, by offering them different price-quantity bundles. We abstract from that possibility here, as we wish to concentrate on price discrimination between insiders and outsiders. We discuss the case of price discrimination between outsiders later in this section.

(i) The firm hires a worker of type 1.

(ii) $p^{o*} > p^{w*} = c'(x^*)$.

(iii) $\frac{p^{o*} - c'(x^*)}{p^{o*}} = \frac{-(q_1^o N_1 + q_2^o N_2)}{E_1(q_1^o)q_1^o(N_1 - 1) + E_2(q_2^o)q_2^o N_2}$, where $E_i(q_i^o) \equiv \frac{1}{p_i'(q_i^o)} \frac{p_i^o}{q_i^o}$, $i = 1, 2$.

Part (ii) in Proposition 1 shows that the company will practice a form of a third-degree price discrimination between employees and non-employees: it will sell its product to the worker at a lower price than the price paid by non-employees. More specifically, the pricing rule for workers is that of a competitive firm, that is, price is equal to marginal cost. The intuition behind this result can be seen by noting that the employee discount works like a two-part tariff. In particular, the consumer surplus generated in equilibrium, $[u(q^{w*}) - q^{w*}u'(q^{w*})] > 0$, counts towards the worker's participation constraint. The optimal strategy for the firm is to maximize this consumer surplus by selling the good to the worker at marginal cost and then extracting the surplus through a lower salary, s^* .

Part (iii) in the proposition says that the mark-up to the outsiders will be slightly higher than the optimal mark-up of a regular monopoly without insiders.⁵ This can be seen most easily in the case where the firm can detect consumer types and practice third degree price discrimination between the two types of consumers outside the firm. Using the proof of Proposition 1, it can be shown that, in this case, the firm again hires a type 1 employee and sells this employee the product

⁵Our model assumes that it is equally costly to supply workers and non-workers. In many actual cases, it is probably less costly to supply the product to employees than it is to supply it to non-employees. If this is the case, there would be an even greater difference between the inside price and the outside price. One factor that could make it effectively less costly to supply workers is the case where the relevant Internal Revenue Service constraints are met and the discounted product is not taxed. These constraints are that the worker's price must be at least equal to twenty percent of the non-worker's price, for a service, and it must be at least equal to the firm's profit as a percentage of total revenue times the non-worker's price, in the case of a good. (See U.S. Internal Revenue Service, 2003). The effect of such a binding constraint is not clear because it raises the worker's price above marginal cost and the fact that payments are not deductible lowers the firm's effective marginal cost.

at marginal cost, while the pricing rules for the two outside consumer types are given by

$$\frac{p_1(q_1^o) - c'(x^*)}{p_1(q_1^o)} = \frac{-1}{E_1(q_1^o)} \frac{N_1}{(N_1 - 1)} \quad (6)$$

for type 1 and

$$\frac{p_2(q_2^o) - c'(x^*)}{p_2(q_2^o)} = \frac{-1}{E_2(q_2^o)} \quad (7)$$

for type 2 consumers. Condition (7) is the usual monopoly pricing rule, whereas condition (6), the analogue to the pricing rule in Proposition 1, says that the price mark-up to the higher preference consumers is higher by the factor of $\frac{N_1}{N_1 - 1}$. This reflects the fact that a higher outside price makes the employee's participation constraint easier to satisfy, because his reservation utility decreases with the outside price. The firm therefore optimally increases the outside price beyond what it would be in the absence of employee discounts. This, however, becomes more costly as the size of the outside market, $(N_1 - 1)$, increases so the deviation from the regular pricing rule decreases with the size of the market and, for very large markets, vanishes entirely.

Finally, part (i) in Proposition 1 says that the firm will prefer to hire the type of worker who likes the good most, i.e., a type-1 worker. Roughly speaking, the reason is that the more a worker values the good, the greater is the increase in his consumer surplus when he receives a discount on the good. This in turn translates into a greater decrease in the salary that is needed to satisfy the worker's participation constraint.

The above analysis suggests two potentially testable empirical predictions. First, firms offering employee discounts should be selling their product to employees at discounted prices near marginal production cost, especially when their workforce is relatively homogenous. While we recognize the difficulty of measuring and comparing preferences, a second potentially testable prediction is that firms offering employee discounts tend to have work forces who have a higher than average

preference for the product being produced by their firm.

3. Job perks as a wage discrimination device

In the preceding analysis, we have assumed that the pool of potential employees always contained both types of workers, which made it possible for the firm to always hire the preferred type of worker. In this section, we extend our analysis in two directions. First, we assume that the pool of job applicants is small, so that with a positive probability the firm cannot attract the desired type of worker. This seems like a reasonable assumption if the position the firm seeks to fill is higher up the corporate ladder, let's say the CEO position. Second, we allow for the possibility that the potential employees differ not only in their valuation of the perk, but also differ with respect to their reservation utilities. We show here that in maximizing profit, the firm creates different bundles of the perk and cash in response to different worker characteristics and marginal costs of acquiring the perk. Our main result in this section is that this strategic bundling can lead the firm to issue perks in a socially inefficient way and we identify the conditions under which the perk is oversupplied, under-supplied, or supplied in an efficient way.

As before, there are two types of potential workers, type 1 having a higher total and marginal valuation for the in-kind product offered by the firm than type 2, and their utility functions again satisfy Assumptions 1a) - 1c). We denote the reservation utility of a type i worker as \bar{u}_i , while $u_i(q)$ is his valuation of the perk provided in quantity q , $i = 1, 2$. The prior probability that a given agent is of type 1 is denoted as π . An agent's type is his private information, so that the firm cannot distinguish between the two types of workers. The worker can be offered a menu of contracts (s_i, q_i, p_i) , where s_i denotes the worker's salary, as in the previous section, while q_i is the amount of the perk sold to the worker at price p_i . The total utility that an agent of type i derives from working for the firm is then $s_i + u_i(q_i) - p_i q_i$.

In the previous section, we showed that the pricing to employees was independent of the prices charged to outsiders. From now on, we therefore ignore non-employees altogether, which allows us to simplify the analysis by not modelling the demand for the firm's product directly. Rather, we will assume that a worker of type i generates a constant revenue y_i for the firm. To eliminate less interesting parametrizations, we restrict our attention to those values for the workers' productivities y_i and the probability π under which the firm finds it optimal to hire either type of worker, rather than offering a contract that would be accepted by one type and rejected by the other type of worker. The firm's cost of acquiring (either purchasing or producing) the product or perk that it offers to its workers is $c(\cdot)$. In Corollaries 1 and 2 presented below, it is necessary to parametrize the cost function by writing $c(q, m)$, where m is a parameter that will allow us to scale the firm's marginal cost of the providing the perk. For this augmented cost function, we replace Assumption 2 with Assumption 2A below.

ASSUMPTION 2.A. $c(0, m) = 0$, $c_q > 0$, c_{qm} , $c_{qq} > 0$, $c_q(0, m) < \infty$, $c_q(q, 0) = 0$, and $\lim_{m \rightarrow \infty} c_q(q, m) = \infty$.

Assumption 2.A defines m as a marginal cost parameter, with greater m indicating a greater marginal cost, for each q . When our analysis does not call for variations in m , we will suppress dependence on m and write total and marginal cost as $c(q)$ and $c'(q)$, respectively.

As before, the perk provided by the firm cannot be purchased by the workers elsewhere and cannot be resold by them to non-employees of the firm. A large office is a good example of such a perk, secretarial support and flexible working hours are two additional examples.

3.1. The set of possible contracts

The firm's general problem in this section is to offer its worker a menu of two contracts, (s_i, q_i, p_i) , $s_i \in R$, $p_i, q_i \geq 0$, $i = 1, 2$, so as to

$$\underset{\{s_i, q_i, p_i\}}{\text{maximize}} \sum_{i=1}^n \pi_i (y_i - s_i + p_i q_i - c(q_i)) \quad (\text{MAX})$$

subject to

$$s_i - p_i q_i + u_i(q_i) - \bar{u}_i \geq 0, \quad i = 1, 2, \quad (\text{PC}_i)$$

$$s_1 - p_1 q_1 + u_1(q_1) \geq s_2 - p_2 q_2 + u_1(q_2), \quad \text{and} \quad (\text{IC}_1)$$

$$s_2 - p_2 q_2 + u_2(q_2) \geq s_1 - p_1 q_1 + u_2(q_1), \quad (\text{IC}_2)$$

where $\pi_1 = \pi$ and $\pi_2 = 1 - \pi$. (PC_i) represent the two types' participation constraints, while (IC_i) is an incentive compatibility constraint for type i , which ensures that a worker of this type does not choose the contract designed for type $j \neq i$.

In this general formulation, the firm can choose any sextuple $(s_1, q_1, p_1, s_2, q_2, p_2)$, subject only to non-negativity constraints for p_i and q_i . However, in reality, the firm's options may be more limited, depending upon the particular economic environment in which it operates. For example, non-discrimination laws may prevent the firm from charging different prices for the perk, which would add an additional constraint to the above problem, $p_1 = p_2 = p$. Alternatively, the firm may need to purchase the perk (say, an office) before filling the job with a particular worker. This would add an extra constraint $q_1 = q_2 = q$. As a yet another illustration, the firm may face an institutional constraint of some kind (say, equity considerations) that prevents it from attaching a menu of salaries to a particular job position. In this case, the problem in (MAX) would have an additional constraint $s_1 = s_2 = s$. Thus, ideally, we would like to analyze the firm's problem not

only as stated above, but also subject to all possible variations with additional constraints on s_i , q_i and p_i of the form

$$z_1 = z_2 = z, \tag{8}$$

where $z_i = s_i, q_i$, or p_i , for $i = 1, 2$.

In addition to the basic problem in (MAX), there are seven variations of the problem with additional constraints on s_i, q_i and p_i of the above form. Fortunately, it turns out that they are all equivalent (in the sense that they yield the same equilibrium outcomes) to one of two general formulations of the problem described in Lemma 1 below.

Lemma 1. *Let $t_i = s_i - p_i q_i$. Any formulation of the firm's optimization problem (MAX) subject to additional constraints on s_i, q_i and p_i of the form expressed in (8) is either equivalent to the general problem in (MAX) or to a problem where the firm chooses (t_i, q_i) , $i = 1, 2$, such that $t_1 = t_2 = t \in R$ and $q_1 = q_2 = q \geq 0$.*

Lemma 1 simplifies the analysis considerably, by narrowing down the set of all relevant economic environments that can be imposed upon the general problem in (MAX) by adding additional constraints of the form (8), to two formally equivalent problems. In one, described in (MAX), the firm faces no additional constraints on its choice variables; in the other, the firm has to offer the same contract, (s, q, p) , to both types of worker, i.e., $s_1 = s_2 = s$, $q_1 = q_2 = q$, and $p_1 = p_2 = p$. To illustrate the logic behind this result, suppose for example that s_i and p_i can vary across the two types of worker, but q_i cannot, that is, it must be that $q_1 = q_2 = q$. Since the workers have quasi-linear utility functions, both the firm and the workers care about s_i and p_i only through the transfer term $t_i = s_i - p_i q_i$. This problem is therefore equivalent to the one where the firm chooses t_i and q . However, if, for example, $t_1 > t_2$, then both types of worker strictly prefer contract (t_1, q) to contract (t_2, q) , which means that no worker will ever select the latter contract. Therefore, this

menu of contracts is equivalent to offering a single contract, $(t_1, q) = (t, q)$.

3.2. The firm cannot offer a menu of contracts

We start by analyzing the simpler, second problem identified in Lemma 1, that is, a situation where the firm cannot offer the agents a menu of contracts; rather, it has to devise a single contract offered to all worker types, that is, $s_1 = s_2 = s$, $q_1 = q_2 = q$ and $p_1 = p_2 = p$. One interpretation of this assumption is that the salary is attached to a job position which the firm needs to fill and the perk is provided as a public good. For example, all employees are located in a very well designed and appointed office building in a desirable location. Another scenario where this assumption is realistic is where the firm has to invest into the perk before hiring a particular worker. For example, the firm builds or rents an office and other complementary inputs for the worker before it knows which type of worker will use it. Note, however, that, as shown in Lemma 1 and the subsequent discussion, this formulation of the problem is formally equivalent to a broader set of problems. For example, it yields the same outcome as the problem in which the firm can offer a menu of contracts, (s_i, q, p_i) , which can differ in salaries and prices charged for the perk, but not in quantities. Note also that because both types of workers are offered the same contract here, (s, q, p) , we can, without loss of generality, set $p = 0$.⁶

In order to provide the intuition for the role of the perk in the optimal employment contract, let us first consider two simple numerical examples.

Example 1.

Suppose that the firm can only provide one unit of the perk (say, an office of a given size). Type 1 values the perk at $u_1 = \$6$ per hour and his reservation utility is $\bar{u}_1 = \$10$ per hour. Type 2 values the perk at $u_2 = \$2$ per hour and her reservation utility is $\bar{u}_2 = \$6$ per hour. The ex ante

⁶To see this, suppose that a contract (s, q, p) is optimal, where $p > 0$. This contract gives the worker utility equal to $s - pq + u_i(q)$. But this is equivalent to a contract (s', q, p') , where $p = 0$ and $s' = s - pq$.

probability of the worker being of type 1 is $\pi = 1/2$. In this setting, if the firm wants to attract either type of worker, it has to offer the wage equal to $s = \max\{\bar{u}_1, \bar{u}_2\} = \10 if the contract does not include the perk, while the wage only needs to be $s' = \$4 = \bar{u}_1 - u_1 = \bar{u}_2 - u_2$ if the contract includes the perk. Hence, the firm is willing to pay up to $s - s' = \$6$ for one unit of the perk. Since on average the perk is only worth $\frac{u_1+u_2}{2} = \$4$ to the workers, the firm will have a tendency to overinvest in it. Note that the perk allows the firm to practice wage discrimination between type 1 and type 2 workers in a similar way as bundling of goods allows firms to indirectly price discriminate among different types of consumers. Under the parameter values of this example, bundling the salary with the perk decreases the differences between the salaries the workers need to receive from $\$4 = \bar{u}_1 - \bar{u}_2$ to $\$0 = (\bar{u}_1 - u_1) - (\bar{u}_2 - u_2)$, which allows the firm to extract the whole $\$4$ surplus (information rent) worker 2 would be getting if the perk were not offered.

Example 2.

Now suppose that type 1's valuation of the perk increases to $u_1 = \$9$ per hour and type 2's reservation utility increases to $\bar{u}_2 = \$8$ per hour; everything else is as in Example 1, that is, $\bar{u}_1 = \$10$, $u_2 = \$2$, and $\pi = 1/2$. In this scenario, if the firm wants to attract either type of worker, it again has to offer a wage equal to $s = \$10$ per hour when the contract does not include the perk, while the wage needs to be $s'' = \bar{u}_2 - u_2 = \6 per hour if the contract includes the perk. Therefore, in this case, the firm is willing to pay at most $s - s'' = \$4$ for one unit of the perk, but the average value of the perk to the workers is $\frac{u_1+u_2}{2} = \$5.50$. Consequently, under these parameter values, the firm has a tendency to underinvest in the perk. Unlike in Example 1, in this scenario the difference between the workers' valuations of the perk, $u_1 - u_2$, is so large that now it is worker 1 who receives an information rent, equal to $\$5 = (\bar{u}_2 - u_2) - (\bar{u}_1 - u_1)$, and this rent is higher than the rent worker 2 would be getting if the contract did not offer the perk, this amount being $\bar{u}_1 - \bar{u}_2 = \2 . This tends to decrease the firm's profit, making the perk component in the optimal contract less

desirable than what would be socially optimal.

Returning to our general setting, the ex-ante efficient amount of the perk, q^e , maximizes the expected total surplus, $\pi y_1 + (1 - \pi)y_2 + \pi u_1(q) + (1 - \pi)u_2(q) - c(q)$. The amount q^e is therefore given by the first order condition

$$\pi u_1'(q^e) + (1 - \pi)u_2'(q^e) = c'(q^e). \quad (9)$$

In contrast, the firm chooses the quantity q^* that solves the following cost-minimization problem:

$$\min_{s,q} (s + c(q))$$

subject to

$$s + u_i(q) - \bar{u}_i \geq 0, \quad i = 1, 2. \quad (\text{PC}_i)$$

We will consider two cases, depending upon the correlation between a worker's reservation utility and the value this worker places on the perk that the firm provides.

3.2.1. Case 1: High valuation workers have higher reservation utility, $\bar{u}_1 > \bar{u}_2$.

To provide an illustration of a setting in which the assumption of positive correlation between perk valuation and reservation utility seems reasonable, suppose that the agents who enjoy the perk good more are also more productive. These agents then have higher reservation utilities because they could command higher incomes in alternative employments or when self-employed. Thus, a person who likes computers will appreciate being given a state of the art lap-top computer (in-kind), but will also know how to use it and therefore will be more productive than someone who does not like computers and does not care much about what kind of computer she uses at home or in the office.

We now introduce some additional notation and proceed with the analysis. Let q_i^e be the first-best efficient quantity of the perk good such that

$$u'_i(q_i^e) = c'(q_i^e), \quad i = 1, 2, \quad (10)$$

and let $\Delta u(q)$ be the function defined by $\Delta u(q) \equiv u_1(q) - u_2(q)$. From Assumption 1a), it must be both that $q_1^e > q_2^e$ and that the function $\Delta u(q)$ is strictly increasing in q . Hence, $\Delta u(q_1^e) > \Delta u(q_2^e)$. Finally, denote as $\Delta \bar{u}$ the difference between the two types' reservation utilities, i.e., $\Delta \bar{u} \equiv \bar{u}_1 - \bar{u}_2$ and let \hat{q} be implicitly defined by $\Delta u(\hat{q}) = \Delta \bar{u}$. Note that, generically, $\hat{q} \neq q^e$. In this setting, the efficiency of the firm's optimal choice of the perk is described by the following proposition.

Proposition 2. *Suppose that the prior probability that the worker is of type 1 is $\pi \in (0, 1)$ and that $\Delta \bar{u} = \bar{u}_1 - \bar{u}_2 > 0$. If the firm offers a uniform contract, then the contract's efficiency is characterized by (i)-(iii) below.*

- (i) *If $\Delta u(q_2^e) \geq \Delta \bar{u}$, then $q^* = q_2^e < q^e$.*
- (ii) *If $\Delta u(q_1^e) \leq \Delta \bar{u}$, then $q^* = q_1^e > q^e$.*
- (iii) *If $\Delta \bar{u} \in (\Delta u(q_2^e), \Delta u(q_1^e))$, then $q^* = \hat{q} \in (q_1^e, q_2^e)$.*

Proposition 2 tells us that the firm typically issues the perk in a socially inefficient way. For some parameter values, the amount of the perk issued by the firm is too large, while for other parameter values it is too low. Specifically, when a type 1 worker values the perk substantially more than a type 2 worker, but the difference between their reservation utilities is relatively small, then the firm needs to worry more about satisfying type 2's than type 1's participation constraint. In this case, the optimal employment contract (s, q) is tailored to suit type 2 workers, offering their optimal, surplus maximizing quantity of the perk, q_2^e . Because q_2^e is lower than the ex-ante efficient level q^e

(which lies between q_2^e and $q_1^e > q_2^e$), in this case the firm under supplies the perk. An alternative view of this process can be obtained by applying the intuition developed in our numerical Example 2. In particular, worker 1's valuation of the perk is so high in this case, that this worker receives an information rent, equal to $[\bar{u}_2 - u_2(q^*)] - [\bar{u}_1 - u_1(q^*)] = \Delta u(q^*) - \Delta \bar{u} > 0$. Because this information rent increases in q^* , the firm has an incentive to limit it by under-supplying the perk.

On the other hand, if the reservation utility of type 1 worker is considerably higher than that of type 2 worker, while their valuations of the perk do not differ very much, then attracting worker 1 is more difficult than attracting worker 2. In this case, the contract is optimally designed to suit worker 1, offering the quantity of the perk, q_1^e , that maximizes this worker's surplus. Because $q_1^e > q^e$, in this case the firm supplies a greater than efficient quantity of the perk. Using again the intuition developed in our numerical examples, when the workers' reservation utilities and valuations for the perk are correlated but worker 1's valuation of the perk is not too high, then worker 2 receives an information rent, equal to $[\bar{u}_1 - u_1(q^*)] - [\bar{u}_2 - u_2(q^*)] = \Delta \bar{u} - \Delta u(q^*) > 0$. Because this information rent decreases in q^* , the firm has an incentive to limit it by over supplying the perk.

Finally, in the intermediate case where satisfying one type's participation constraint does not automatically imply that the other type's participation constraint is satisfied, as well, the quantity of the perk is intermediate, between q_1^e and q_2^e . However, full efficiency can only be obtained in the special case in which the workers' valuations and reservation utilities are such that neither of them receives an information rent, that is, $\Delta \bar{u} - \Delta u(q^*) = 0$.

In order to restate the results of Proposition 2 in a way that is more suitable for devising a possible test of our theory, we use Assumption 2.A and write the firm's cost of the perk as $c(q, m)$.

We have

Corollary 1. *Suppose that $\Delta \bar{u} > 0$ and the firm offers a uniform contract. There exists an*

$m^* \in [0, \infty)$ such that $q^* \leq q^e$ if and only if $m \leq m^*$. If $\hat{q} \neq q^e$ (which is generically true), then $q^* < q^e$ if $m < m^*$ and $q^* > q^e$ if $m \geq m^*$.

This corollary offers a potentially testable prediction. It says that excessive perks should more likely be observed when the marginal cost of the perk is relatively high, but not when the marginal cost is relatively low. The intuition for this result is as in the following description. When the workers' reservation utilities are correlated with their valuations of the perk, so that $\Delta\bar{u} = \bar{u}_1 - \bar{u}_2 > 0$, then, in the absence of the perk in the employment contract, worker 2 receives an information rent equal to $\Delta\bar{u}$. From the discussion following Proposition 2, we know that if bundling the perk with cash in the employment contract allows the firm to decrease worker 2's information rent, the firm will have an incentive to oversupply the perk. But the perk tends to decrease the information rent when the difference in the workers' valuations of the perk is relatively small, so that $\Delta u(q^*) \leq \Delta\bar{u}$. Since $\Delta u(q^*)$ increases in q^* , which decreases in the marginal cost of the perk as measured by m , $\Delta u(q^*)$ tends to be small when m is large. Hence, oversupply requires that the marginal cost of the perk is relatively high. On the other hand, when m is small, then the optimal quantity of the perk is large, which in turn makes the difference in valuations, $\Delta u(q^*)$, large. In this case the perk increases the rent that accrues to worker 2, inducing the firm to restrict the perk's provision below the efficient level.

As mentioned in the Introduction, the result in Corollary 1 offers an alternative view of the motives that lead some firms to provide excessive perks to their executives. According to the accepted wisdom, lavish perks represent a manifestation of agency problems. In our framework, excessive provision of perks is a deliberate profit-maximizing strategy designed by the firms to better implement wage discrimination between different types of managers.

3.2.2. Case 2: High valuation workers have lower reservation utility, $\bar{u}_1 \leq \bar{u}_2$.

As an example of a setting in which the assumption of a negative correlation between perk valuation and reservation utility would apply, suppose that a worker's output, y_i , depends upon the level of effort that the worker provides at a personal cost of $g_i(y_i)$. Both types of workers are equally productive in their alternative employment, so that, due to a competitive outside labor market, both can get the same reservation wage, w . However, type 1 has lower production cost than type 2, $g_1(y) < g_2(y)$, in addition to having higher total and marginal valuation for the in-kind product offered by the firm. For instance, a person who enjoys contact with people may place a higher value on an office in a desirable downtown location, while at the same time have a low cost of doing her job, which requires people skills. The participation constraint of worker i is then $s + u_i(q) - g_i(y) - w \geq 0$. Denoting $w + g_i(y)$ as \bar{u}_i , this constraint becomes $s + u_i(q) - \bar{u}_i \geq 0$, with $\bar{u}_1 < \bar{u}_2$.

The analysis of this scenario is straightforward: Since in this case $\Delta\bar{u} = \bar{u}_1 - \bar{u}_2 \leq 0$, we always have $\Delta u(q_2^e) \geq \Delta\bar{u}$. Using part (i) in Proposition 2, we immediately obtain Proposition 3 below.

Proposition 3. *Suppose that the prior probability that the worker is of type 1 is $\pi \in (0, 1)$ and that $\Delta\bar{u} = \bar{u}_1 - \bar{u}_2 \leq 0$. If the firm offers a uniform contract, then the optimal quantity of the perk is $q^* = q_2^e < q^e$.*

Thus, in this case the firm always underinvests in the provision of perks.

3.3. The Firm Can Offer a Menu of Contracts

In this subsection, we generalize the previous model to the case where the firm can offer a menu of contracts, which is the first problem identified in Lemma 1. The firm can design a compensation contract (s_i, q_i, p_i) intended for a type i employee by specifying a salary, an in-kind compensation,

and the price of the in-kind good. The logic of Lemma 1 implies that this problem is equivalent to several other formulations. In one of them, the firm chooses arbitrary s_i and q_i but sets the prices $p_1 = p_2 = 0$. To see this, notice that p_i affects the agent's overall utility and the firm's profit only through the term $t_i = s_i - p_i q_i$. Since for any given p_i one can find an s_i such that t_i remains the same, p_i can be without loss of generality normalized to zero. Thus, in the subsequent analysis, we will set $p_1 = p_2 = 0$, so that the agent i 's total utility is $s_i + u_i(q_i)$. Note also that the equilibrium contract in this setting, (s_i^*, q_i^*) , yields the same outcome as a contract of the form (s_i, p_i) , where the principal quotes the prices of the in-kind good and salaries and allows employee demand to determine the resultant quantities. In such a case, the agent's total utility would be $s_i + u_i(q_i) - p_i q_i$. The principal would compute prices as $\hat{p}_i = u_i'(q_i^*)$ and salaries as $\hat{s}_i = s_i^* + \hat{p}_i q_i^*$. By issuing the contract (\hat{s}_i, \hat{p}_i) , the same equilibrium would be achieved as with the contract (s_i^*, q_i^*) .

Examples of the quantity type contract include cases where the firm offers employees the option of, say, less salary and more of a benefit, or conversely. Contract workers, for example, trade off benefits for a higher salary. Professional workers wanting more flexible hours and infrequent travel might self select into a position in which salary is less as opposed to a career type job where inflexible hours and frequent travel are requirements. Examples of the price type contract include medical and dental plan menus offered to employees at different prices.

In the case where a zero price is paid for the in-kind good and quantities are set by the principal, the firm's problem can be written as

$$\max_{\{s_1, s_2, q_1, q_2\}} \pi(y_1 - s_1 - c(q_1)) + (1 - \pi)(y_2 - s_2 - c(q_2))$$

subject to

$$s_i + u_i(q_i) - \bar{u}_i \geq 0, \quad i = 1, 2, \quad (\text{PC}_i)$$

$$s_1 + u_1(q_1) \geq s_2 + u_1(q_2), \quad (\text{IC}_1)$$

$$s_2 + u_2(q_2) \geq s_1 + u_2(q_1). \quad (\text{IC}_2)$$

(PC_{*i*}) again represent the two types' participation constraints, while (IC_{*i*}) is an incentive compatibility constraint for type *i*, which ensures that a worker of this type does not choose the contract designed for type $j \neq i$. In the present problem, the benchmark efficient levels of q_i , denoted as q_i^e , are the solutions to (10). We will denote the principal's solution values as q_i^* and s_i^* . The following proposition defines the firm's optimal choices of the in-kind product.

Proposition 4. *Suppose that the prior probability that the worker is of type 1 is $\pi \in (0, 1)$ and that the firm can offer a menu of contracts. The efficiency of the firm's profit maximizing menu of contracts is then characterized by (i)-(iv) below:*

(i) $q_1^* \geq q_1^e$ and $q_2^* \leq q_2^e$.

(ii) If $\Delta u(q_2^e) > \Delta \bar{u}$, then $q_1^* = q_1^e$ and $q_2^* < q_2^e$.

(iii) If $\Delta u(q_1^e) < \Delta \bar{u}$, then $q_1^* > q_1^e$ and $q_2^* = q_2^e$.

(iv) If $\Delta \bar{u} \in [\Delta u(q_2^e), \Delta u(q_1^e)]$, then $q_i^* = q_i^e$, $i = 1, 2$.

Proposition 4 demonstrates that the qualitative results obtained in Propositions 2 and 3 continue to hold even if the firm can offer a menu of contracts. In this case, though, full efficiency is feasible for some parameter values, namely, for intermediate values of the difference in the agents' reservation utilities, $\Delta \bar{u}$. Otherwise, however, the firm again over-supplies or under-supplies the perk, as before, depending upon the correlation between the workers' reservation utilities and their valuations of the perk. As in Proposition 2, we can express these results in a way that is better amenable for drawing empirical predictions and, for $\Delta \bar{u} > 0$, relate cases (ii)-(iv) of Proposition 4 to the magnitude of

the firm's marginal cost of providing the in-kind good. We again use Assumption 2.A and the cost function $c(q, m)$.

Corollary 2. *Assume that $\Delta\bar{u} > 0$ and that the firm offers a menu of contracts. If $\lim_{q \rightarrow \infty} \Delta u(q) >$*

$\Delta\bar{u}$, there exist $m'' > m' > 0$ such that,

- (i) $q_1^* = q_1^e$ and $q_2^* < q_2^e$ if $m < m'$,
- (ii) $q_1^* > q_1^e$ and $q_2^* = q_2^e$ if $m > m''$, and
- (iii) $q_1^* = q_1^e$ and $q_2^* = q_2^e$ if $m \in [m', m'']$.

If $\lim_{q \rightarrow \infty} \Delta u(q) \leq \Delta\bar{u}$, then (ii) holds for all $m > 0$.

Corollary 2 is a counterpart to Corollary 1 in the previous subsection. It demonstrates the robustness of our earlier result that oversupply of the perk tends to be optimal when (a) the workers' reservation utilities are positively correlated with their valuations of the perk (i.e., $\Delta\bar{u} > 0$) and (b) the perk's marginal cost is high. The perk is optimally under-supplied when the opposite to (a) or (b) is true.

The intuition for the cases included in Proposition 4 and its corollary can be seen by analyzing the case of over supply to the high preference type. The condition that $\Delta\bar{u} - \Delta u(q_1^e) > 0$ is met if m is sufficiently large (Corollary 2), because $\Delta u(q_1^e)$ is decreasing in m . In equilibrium, we have that it is relatively difficult to meet PC₁, while it is easy to meet PC₂. This, along with the requirement that IC_{*i*} be met, results in $\bar{u}_1 = s_1^* + u_1(q_1^*) > s_2^* + u_1(q_2^e)$ and $\bar{u}_2 < s_2^* + u_2(q_2^e) = s_1^* + u_2(q_1^*)$, where $q_2^* = q_2^e$. The rent accruing to type 1 is $s_1^* + u_1(q_1^*) - \bar{u}_1 = 0$, while it is $s_2^* + u_2(q_2^e) - \bar{u}_2 = s_1^* + u_2(q_1^*) - \bar{u}_2 = \Delta\bar{u} - \Delta u(q_1^*) > 0$ for type 2 (we use $s_1^* = \bar{u}_1 - u_1(q_1^*)$ to obtain the last equality). The firm finds it optimal to reduce this rent by raising q_1^* above q_1^e so as to raise $\Delta u(q_1^*)$. The case of under supply to the low type has an analogous interpretation. Finally, when $\Delta\bar{u} > 0$, one can

always find an intermediate m placing $\Delta\bar{u}$ between $\Delta u(q_2^e)$ and $\Delta u(q_1^e)$. In this case it is possible to satisfy both workers' participation constraints (PC_i) with equality, while not violating their incentive compatibility constraints (IC_i). This means that neither worker receives an information rent, so that the firm has no incentive to deviate from the fully efficient amounts of the perk.

4. Conclusion

In this paper, we present a new explanation for the use of non-cash compensation by firms. We consider two broad categories of such compensation, namely discounts on the firm's product and in-kind compensation.

When firms can always hire their preferred type of worker, optimal employee discounting entails offering the firm's product at marginal cost and marking the product above marginal cost for nonemployees. This represents a value enhancing price discrimination strategy. If there are potential employees who value the firm's product more than others, then this price discrimination strategy will be used to attract (separate) those types to seek employment with the firm. The idea developed here is that by pricing at marginal cost, the firm can first create the employee's consumer surplus and then extract it through a lower salary. Consequently, the firm wants to hire those who like the firm's product the most, because these types have deeper surplus pockets.

We also characterize optimal bundling of cash and in-kind payments when the preferred employee type is not always among the job applicants. We show that whether or not a menu of contracts is offered, the bundling of cash and in-kind compensation allows the firm to extract a part of the information rents obtained by the employees due to their private information about their preferences and reservation utilities. In general, the firm's desire to minimize the information rent obtained by one or the other type of worker will lead the firm to offer the in-kind good in a socially inefficient way. Typically, oversupply of the perk is optimal if there is positive correlation between

preference and reservation utility and if the marginal cost of the perk is high. If the marginal cost of the perk is low or if there is negative correlation between preference and reservation utility, then there is optimal under supply of the perk. An interesting implication of this analysis is that in situations where high preference types are more productive and where marginal costs of perks are high, it may be a profit maximizing strategy to provide the perks in excessive quantities. To the extent that these conditions accurately describe top managers of today's major corporations, our theory provides an alternative to the predominant view that some executive perks are lavishly excessive due to agency problems.

Appendix

Proof of Proposition 1: In solving the firm's optimization problem, we will first ignore the self-selection constraint (3). We will then show that the solution that we identify satisfies this constraint.

Standard arguments imply that both (2) and (4) will hold with equality in equilibrium. Plug the expression for x from (4) to the objective function (1). Similarly, solve for s from (2) and plug to (1). Finally, use (5) to differentiate q_j^o with respect to q_i^o : $\partial q_j^o / \partial q_i^o = p'_i(q_i^o) / p'_j(q_j^o) > 0$. Ignoring (3) for the moment, the firm's problem then simplifies to

$$\max_{i, q_i^o, q_i^w} q_i^o p_i(q_i^o) N_i + q_j^o p_j(q_j^o) N_j + u_i(q_i^w) - u_i(q_i^o) - c(q_i^o(N_i - 1) + q_j^o N_j + q_i^w) - \bar{s}, \quad (\text{a.1})$$

subject to

$$\frac{\partial q_j^o}{\partial q_i^o} = \frac{p'_i(q_i^o)}{p'_j(q_j^o)}. \quad (\text{a.2})$$

The first order condition with respect to q_i^w yields $u'_i(q_i^{w*}) = c'(x^*)$. Because agent i 's optimal consumption q_i^{w*} is given by $u'(q_i^{w*}) = p^{w*}$, this proves the equality in part (ii) of the proposition.

The first order condition with respect to q_i^o is

$$\left[p_i(q_i^{o*}) + q_i^{o*} p'_i(q_i^{o*}) \right] N_i + \frac{\partial q_j^{o*}}{\partial q_i^{o*}} \left[p_j(q_j^{o*}) + q_j^{o*} p'_j(q_j^{o*}) \right] N_j = u'_i(q_i^o) + c'(x^*) \left[(N_i - 1) + \frac{\partial q_j^{o*}}{\partial q_i^{o*}} N_j \right].$$

From (5), $p_i(q_i^{o*}) = p_j(q_j^{o*}) = p^{o*}$, and from the agents' optimization, $u'(q_i^{o*}) = p^{o*}$. Using these two equalities and (a.2) and rearranging the above first order condition yields

$$\left[p^{o*} - c'(x^*) \right] \left[(N_i - 1) + \frac{p'_i(q_i^{o*})}{p'_j(q_j^{o*})} N_j \right] = -p'_i(q_i^{o*}) (N_i q_i^{o*} + N_j q_j^{o*}) > 0. \quad (\text{a.3})$$

Because $N_i > 1$ and $\frac{p'_i(q_i^{o*})}{p'_j(q_j^{o*})} > 0$, the above inequality implies $p^{o*} > c'(x^*)$, which is the inequality in part (ii). To finish the proof of this part, we need to check that condition (3) is satisfied. Substituting for \bar{s} from (2) and rearranging, we can see that condition (3) holds for $i = 1$ and $j = 2$ if and only if

$$u_2(q_2^w) - q_2^w p^{w*} - [u_2(q_2^o) - p^{o*} q_2^o] < u_1(q_1^w) - q_1^w p^{w*} - [u_1(q_1^o) - p^{o*} q_1^o]. \quad (\text{a.4})$$

Now, define a function $u(q, k)$ as follows: (i) $u(q, k)$ is differentiable in both arguments, with $\partial u(q, k)/\partial k > 0$ and $\partial^2 u(q, k)/\partial q \partial k > 0$; and (ii) there exist k_1 and k_2 , $k_1 > k_2$, such that $u(q, k_i) = u_i(q)$ (and, hence, also $\partial u(q, k_i)/\partial q = u'_i(q)$), $i = 1, 2$. Then the inequality in (a.4) holds if the expression

$$u(q^w(k), k) - q^w(k) p^w - [u(q^o(k), k) - q^o(k) p^o] \quad (\text{a.5})$$

increases in k for all k . Here, $q(k)$ is given by the first order condition to the agents' optimization problem, $\partial u(q, k)/\partial q = p$, which implies that $q'(k) = -[\partial^2 u(q, k)/\partial q \partial k] / [\partial^2 u(q, k)/\partial q^2] > 0$.

Differentiating (a.5) with respect to k and cancelling out terms yields

$$\frac{\partial(\text{a.5})}{\partial k} = \frac{\partial u(q^w, k)}{\partial k} - \frac{\partial u(q^o, k)}{\partial k}.$$

Integrating with respect to q , we obtain

$$\frac{\partial(\text{a.5})}{\partial k} = \int_{q^o}^{q^w} \frac{\partial^2 u(q, k)}{\partial k \partial q} dq > 0,$$

where the inequality follows because $q^w > q^o$ and $\partial^2 u(q, k)/\partial q \partial k > 0$. Thus, (a.5) increases in k , which means that this expression is larger when evaluated at k_1 than at $k_2 < k_1$, which yields inequality (a.4).

Part (ii) will be proved by the way of contradiction. Suppose that $i = 2$, so that the firm's profit is $\pi(2) = q_2^o p_2(q_2^o) N_2 + q_1^o p_1(q_1^o) N_1 + u_2(q_2^w) - u_2(q_2^o) - c(q_2^o N_2 + q_1^o N_1 + q_2^w - q_2^o) - \bar{s}$. Now replace worker 2 by an agent of type 1, while holding q_1^o , q_2^o , and p^o fixed. The firm's profit after this swap in workers is given by $\pi(1) = q_2^o p_2(q_2^o) N_2 + q_1^o p_1(q_1^o) N_1 + u_1(q_1^w) - u_1(q_1^o) - c(q_2^o N_2 + q_1^o N_1 + q_1^w - q_1^o) - \bar{s}$. Set p^w so that $q_1^w - q_1^o = q_2^w - q_2^o$. Then $c(x_2) = c(x_1)$ and

$$\pi(1) - \pi(2) = u_1(q_1^w) - u_1(q_1^o) - [u_2(q_2^w) - u_2(q_2^o)] = \int_{q_1^o}^{q_1^w} u_1'(q) dq - \int_{q_2^o}^{q_2^w} u_2'(q) dq > 0,$$

where the inequality follows because (i) $q_1^w - q_1^o = q_2^w - q_2^o$ and $q_1^o > q_2^o$ imply that there exists a constant $a > 0$ such that $\int_{q_1^o}^{q_1^w} u_1'(q) dq = \int_{q_2^o+a}^{q_2^w+a} u_1'(q) dq$, and (ii) $u_1'(q_1^o) = u_2'(q_2^o)$ together with Assumption 2 imply $u_1'(q+a) > u_2'(q)$ for any $q > q_2^o$ and a as defined in (i). Thus $\pi(1) > \pi(2)$. Since q_1^o , q_2^o , p^o , p^w used to obtain $\pi(1)$ were not chosen so as to maximize the firm's profit, the optimal profit from employing a worker of type 1 is at least as high as $\pi(1) > \pi(2)$. This concludes the proof of part (i). Part (iii) follows directly from parts (i) and (ii) and (a.3). ■

Proof of Lemma 1: The constrained optimization problem in (MAX), where the firm maximizes over (s_i, q_i, p_i) , $s_i \in R$, $p_i, q_i \geq 0$, is equivalent to a maximization problem over (t_i, q_i) , $t_i \in R, q_i \geq 0$, $i = 1, 2$. To see this, notice that for any choice of $s_i \in R$, and $p_i, q_i \geq 0$ there exists a $t_i \in R$, such that $t_i = s_i - p_i q_i$. Similarly, for any $t_i \in R$, there exist $s_i \in R$, and $p_i, q_i \geq 0$ such that $t_i = s_i - p_i q_i$. Since the transformation $t_i = s_i - p_i q_i$ preserves both the firm's objective function and the constraints, the choice over (t_i, q_i) yields the same outcome as the choice over (s_i, q_i, p_i) . This can be mechanically checked by substituting t_i into (MAX) and generating the first order conditions in the independent variables t_i and q_i . These conditions are identical to those of the original problem (MAX) with choice variables (s_i, q_i, p_i) . Thus, one only needs to consider four possibilities: (i) t_i and q_i are subject to no additional constraints, (ii) t_i are unconstrained but

$q_1 = q_2 = q$, (iii) q_i are unconstrained but $t_1 = t_2 = t$, and (iv) $q_1 = q_2 = q$ and $t_1 = t_2 = t$.

As we have proved above, (i) is equivalent to the problem in (MAX). Cases (ii) and (iii), on the other hand, are both equivalent to case (iv). To see this, look at case (ii) first and suppose that $t_i > t_j$, $i \neq j$. In this case, the contract (t_i, q) is strictly preferred by both types to the contract (t_j, q) . Therefore, it is not possible to satisfy the two incentive compatibility constraints (IC₁) and (IC₂) simultaneously. Hence, it must be $t_i = t_j$, which makes the firm's problem equivalent to that in case (iv). The reasoning about the equivalence between cases (iii) and (iv) is analogous. This proves that the only two relevant cases to consider are case (i) (which is equivalent to (MAX)) and case (iv). ■

Proof of Proposition 2: Let λ_i be the Lagrange multiplier associated with the participation constraint (PC_{*i*}). The firm's problem is then given by the Lagrangian

$$\min_{s,q} \left(s + c(q) - \sum_{i=1}^2 \lambda_i (s + u_i(q) - \bar{u}_i) \right),$$

which yields the first order conditions

$$\lambda_1 + \lambda_2 = 1 \tag{a.6}$$

and

$$\lambda_1 u'_1(q) + \lambda_2 u'_2(q) = c'(q). \tag{a.7}$$

Suppose first that $\lambda_1 = 0$ and $\lambda_2 > 0$. Then (a.6) and (a.7) imply $\lambda_2 = 1$ and $u'_2(q^*) = c'(q^*)$, so that $q^* = q_2^e$. This is the solution to the firm's problem if it also satisfies the two participation constraints (PC_{*i*}). Since $\lambda_2 > 0$, s must be chosen such that (PC₂) holds with equality when $q = q_2^e$. (PC₁) then holds if and only if $\Delta u(q_2^e) \geq \Delta \bar{u}$, which is the condition in part (i) of the proposition. To conclude the proof of this part, note that $q_2^e < q^e$ because $u'_2(q) < \pi u'_1(q) + (1 - \pi)u'_2(q)$ for any

$q > 0$ and $\pi > 0$.

Next suppose that $\lambda_1 > 0$ and $\lambda_2 = 0$. Then (1) and (2) imply $\lambda_1 = 1$ and $u'_1(q^*) = c'(q^*)$, so that $q^* = q_1^e$. Since $\lambda_1 > 0$, s must be chosen such that (PC₁) holds with equality when $q = q_1^e$. (PC₂) then holds if and only if $\Delta u(q_1^e) \leq \Delta \bar{u}$, which is the condition in part (ii) of the proposition. Also, $q_1^e > q^e$ because $u'_1(q) > \pi u'_1(q) + (1 - \pi)u'_2(q)$ for any $q > 0$ and $\pi < 1$.

Finally, if $\Delta u(q_1^e) > \Delta \bar{u} > \Delta u(q_2^e)$, then neither of the above two cases applies, so that it must be $\lambda_1 > 0$ and $\lambda_2 > 0$. Therefore, both (PC_{*i*}) constraints must be binding, which implies $\Delta u(q^*) = \Delta \bar{u}$, so that $q^* = \hat{q}$. Since $\lambda_1 > 0$, $\lambda_2 > 0$, and $\lambda_1 + \lambda_2 = 1$, we have $\lambda_1, \lambda_2 \in (0, 1)$, so that $u'_1(q) > \lambda_1 u'_1(q) + \lambda_2 u'_2(q) > u'_2(q)$ for any $q > 0$. This means that $\hat{q} \in (q_1^e, q_2^e)$. ■

Proof of Corollary 1: Recall that q_i^e is given by $u'_i(q_i^e) = c_q(q, m)$, $i = 1, 2$. By Assumption 1a) and 2.A, it must be that $\lim_{m \rightarrow 0} q_i^e(m) = \infty$ and $\lim_{m \rightarrow \infty} q_i^e(m) = 0$. The latter implies that $\lim_{m \rightarrow \infty} \Delta u(q_i^e(m)) = 0$ for $i = 1, 2$. Recall also that $\Delta u(q)$ increases in q .

Suppose first that $\Delta \bar{u} \geq \lim_{m \rightarrow 0} \Delta u(q_i^e(m)) = \lim_{q_i^e \rightarrow \infty} \Delta u(q_i^e)$. Then it must be that $\Delta u(q_i^e(m)) \leq \Delta \bar{u}$ for all m , because $\Delta u(\cdot)$ is decreasing in m . Hence, part (ii) in Proposition 2 always applies, which means that $q^* = q_1^e > q^e$ for all m . In this case, $m^* = 0$.

Now suppose that $\Delta \bar{u} < \lim_{m \rightarrow 0} \Delta u(q_i^e(m))$. Since $\lim_{m \rightarrow \infty} \Delta u(q_i^e(m)) = 0$ and $\Delta u(q_i^e(m))$ is continuous and monotonically decreasing in m , there exist unique m_1 and m_2 from $(0, \infty)$ such that $\Delta u(q_i^e(m_i)) = 0$, $i = 1, 2$. Moreover, because $q_1^e(m) > q_2^e(m)$ for any $m \in (0, \infty)$, we have that $m_1 < m_2$. Hence, $\Delta u(q_2^e) \geq \Delta \bar{u}$ if $m \in [0, m_1)$, $\Delta u(q_2^e) < \Delta \bar{u} < \Delta u(q_1^e)$ if $m \in (m_1, m_2)$, and $\Delta u(q_1^e) \leq \Delta \bar{u}$ if $m \in [m_2, \infty)$. Proposition 2 then implies that

$$q^* = q_2^e < q^e \quad \text{if } m \in [0, m_1], \quad (\text{a.8})$$

$$q^* = \hat{q} \quad \text{if } m \in (m_1, m_2), \text{ and} \quad (\text{a.9})$$

$$q^* = q_1^e > q^e \quad \text{if } m \in [m_2, \infty). \quad (\text{a.10})$$

Now, generically, $\hat{q} \neq q^e$. (a.8) – (a.9) then imply that if $\hat{q} < q^e$, it must be that $q^* < q^e$ for all $m \in [0, m_2)$ and $q^* > q^e$ for all $m \in [m_2, \infty)$. Similarly, if $\hat{q} > q^e$, then $q^* < q^e$ for all $m \in [0, m_1]$ and $q^* > q^e$ for all $m \in (m_1, \infty)$. Setting $m^* = m_2$ when $\hat{q} < q^e$ and $m^* = m_1$ when $\hat{q} > q^e$ concludes the proof for the second claim in the proposition.

Finally, if $\hat{q} = q^e$, (a.8) – (a.9) imply that $q^* \leq q^e$ if and only if $m < m^*$, where $m^* = m_2$. ■

Proof of Proposition 4: (i) The relevant Lagrangian function for the principal is written as

$$L = \pi(y_1 - s_1 - c(q_1)) + (1 - \pi)(y_2 - s_2 - c(q_2)) + \sum_{i=1}^2 \lambda_i [s_i + u_i(q_i) - \bar{u}_i] + \sum_{i=1, j \neq i}^2 \mu_i [s_i + u_i(q_i) - s_j - u_j(q_j)].$$

After some rearranging, the first order conditions for q_i^* and s_i^* are given by

$$u_1'(q_1^*) = c'(q_1^*) - \frac{\mu_2}{\pi} \Delta u'(q_1^*), \quad (\text{a.11})$$

$$u_2'(q_2^*) = c'(q_2^*) + \frac{\mu_1}{(1 - \pi)} \Delta u'(q_2^*), \quad (\text{a.12})$$

$$\pi = \lambda_1 + \mu_1 - \mu_2, \quad (\text{a.13})$$

$$(1 - \pi) = \lambda_2 + \mu_2 - \mu_1. \quad (\text{a.14})$$

By $\mu_i \geq 0$ and Assumption 1c), the result holds, from (a.11) and (a.12).

(ii) Suppose that $\Delta u(q_2^e) > \Delta \bar{u}$. First we show that both IC₁ cannot be binding. If they were both binding, together they would imply $\Delta u(q_1^*) = \Delta u(q_2^*)$, which cannot hold, because $\Delta u(\cdot)$ is a strictly increasing function. Next, we show that $q_2^* < q_2^e$. Assume to the contrary that $q_2^* = q_2^e$, in which case $\mu_1 = 0$. From (a.13), $\lambda_1 - \mu_2 = \pi$ so that $\lambda_1 > 0$ and PC₁ is binding. From the PC_i and IC_i we have $\bar{u}_1 = s_1 + u_1(q_1^*) \geq s_2 + u_1(q_2^e) > s_2 + u_2(q_2^e) \geq \bar{u}_2$. Thus, $s_2 \leq \bar{u}_1 - u_1(q_2^e)$ and $s_2 \geq \bar{u}_2 - u_2(q_2^e)$, so that $\Delta \bar{u} \geq \Delta u(q_2^e)$, and we have a contradiction. Therefore, it must be that $q_2^* < q_2^e$. This implies $\mu_1 > 0$, so that IC₁ is binding. Since both IC_i cannot be binding, IC₂ must be nonbinding. Whence, $\mu_2 = 0$ and, from (a.11), $q_1^* = q_1^e$.

(iii) Consider q_1^* and suppose to the contrary that $q_1^* = q_1^e$ in which case $\mu_2 = 0$, from (a.11). From (a.14), $\lambda_2 - \mu_1 = (1 - \pi)$, so that $\lambda_2 > 0$ and PC_2 is binding. From the PC_i and IC_i we have $\bar{u}_2 = s_2 + u_2(q_2^*) \geq s_1 + u_2(q_1^e)$ and $s_1 + u_1(q_1^e) \geq \bar{u}_1$. Therefore, $s_1 \geq \bar{u}_1 - u_1(q_1^e)$ and $s_1 \leq \bar{u}_2 - u_2(q_1^e)$, so that $\Delta\bar{u} \leq \Delta u(q_1^e)$ and we have a contradiction. From (14), $q_1^* > q_1^e$ implies that $\mu_2 > 0$, which means that IC_2 is binding. From the proof of (ii), both IC_i cannot be binding, so that IC_1 is nonbinding and $\mu_1 = 0$. The latter implies that $q_2^* = q_2^e$.

(iv) Begin by setting $q_i^* = q_i^e$ through $c'(q_i^e) = u'_i(q_i^e)$, $i = 1, 2$. If we can show that, under the assumed parametric specifications, this fully efficient solution satisfies the PC_i and IC_i constraints, then it is optimal. To this purpose, set s_i^* such that $\bar{u}_i = s_i^* + u_i(q_i^e)$. First check IC_2 . We have $s_2^* + u_2(q_2^e) \geq s_1^* + u_2(q_1^e)$ if and only if $\bar{u}_2 \geq \bar{u}_1 - u_1(q_1^e) + u_2(q_1^e)$ which in turn is true if and only if $\Delta\bar{u} \leq \Delta u(q_1^e)$. Second check IC_1 . We have $s_1^* + u_1(q_1^e) \geq s_2^* + u_1(q_2^e)$ if and only if $\bar{u}_1 \geq \bar{u}_2 - u_2(q_2^e) + u_1(q_2^e)$ which in turn is true if and only if $\Delta\bar{u} \geq \Delta u(q_2^e)$. ■

Proof of Corollary 2: (i) Fix $\Delta\bar{u} > 0$ and define $q_i^e(m)$ from $u'_i(q_i^e) = c_q(q, m)$. It is clear that $q_2^{e'}(m) < 0$ and that $\phi(m) \equiv \Delta u(q_2^e(m))$ satisfies $\phi'(m) < 0$. Further, we have $\lim_{m \rightarrow \infty} q_2^e(m) = 0$, $\lim_{m \rightarrow 0} q_2^e(m) = +\infty$, $\lim_{m \rightarrow \infty} \phi(m) = 0$, and $\lim_{m \rightarrow 0} \phi(m) > \Delta\bar{u}$ (by $\lim_{m \rightarrow 0} \phi(m) = \lim_{q \rightarrow \infty} \Delta u(q) > \Delta\bar{u}$). Thus, there is a finite and positive m' such that $\Delta u_1(q_2^e(m)) > \Delta\bar{u}$, if $m < m'$.

(ii) Fix a $\Delta\bar{u} > 0$ and define $q_i^e(m)$ as in Part (i). Define $\Phi(m) \equiv \Delta u(q_1^e(m))$. We have $\lim_{m \rightarrow \infty} q_1^e(m) = 0$, $\lim_{m \rightarrow 0} q_1^e(m) = +\infty$, $\lim_{m \rightarrow \infty} \Phi(m) = 0$ with $q_1^{e'}(m) < 0$ and $\Phi'(m) < 0$. Thus, there exists a finite and positive m'' such that $\Delta\bar{u} > \Delta u(q_1^e(m))$, if $m > m''$.

(iii) Part (iii) follows from the proofs of parts (i) and (ii).

Finally if $\lim_{q \rightarrow \infty} \Delta u(q) \leq \Delta\bar{u}$, then because $\Delta u(q)$ is increasing in q , we have that $\Delta u(q) \leq \Delta\bar{u}$ for all $q > 0$. Part (iii) of Proposition 4 applies and, thus, (ii) of Corollary 2 holds. ■

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