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Author(s): Sugato Bhattacharyya and Francine Lafontaine
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Double-sided moral hazard and the nature of share contracts

Sugato Bhattacharyya*

and

Francine Lafontaine**

Contractual arrangements involving revenue/profit sharing are often based on fairly simple, often linear, rules. In addition, in many contexts these contracts are not finely adjusted to the particular circumstances of individual agents or markets, nor do they vary over time to the extent current theories based on optimal contracting suggest they should. We develop a simple model of such revenue- or profit-sharing arrangements based on double-sided moral hazard and show that this model can account for many of these stylized facts. More specifically, the model shows that linear contracts can be optimal and that benefits from customizing terms can, in some cases, be quite limited, if not zero.

1. Introduction

■ In this article we develop a simple double-sided moral hazard model of contractual arrangements involving some degree of revenue or profit sharing, such as franchising, sharecropping, licensing, commercial leasing, and author-publisher contracts. We also examine how well this model can explain some of the interesting characteristics of these institutional arrangements.

We focus on double-sided moral hazard as an explanation for these types of contracts first because of its intuitive appeal. The notion that double-sided moral hazard can explain various such institutional arrangements is not new. Indeed, Reid (1977) first used this idea to explain the existence and form of sharecropping contracts, while Rubin (1978) first suggested it as an explanation for franchising. These arguments have since been formalized by Eswaran and Kotwal (1985) for sharecropping and by Mathewson and Winter (1985) and Lal (1990) for franchising.[1]

*University of Michigan.

**University of Michigan and NBER.

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[1] Analyses in other areas based on double-sided moral hazard include Cooper and Ross (1985), Emons (1988), and Dybvig and Lutz (1993), who all examine how double-sided moral hazard may explain characteristics of product warranty contracts. Other contributions include Mann and Wissink (1988), Demski and

Our interest in double-sided moral hazard as an explanation for these types of arrangements stems more importantly from the support it has received in the empirical literature. In the case of franchising arrangements, Brickley and Dark (1987), Norton (1988), Lafontaine (1992a), and Sen (1993) all find results that are consistent with the existence of moral hazard on the franchisee's side. In addition, Lafontaine (1992a), Sen (1993), and Scott (1995) find support for the notion that there is moral hazard on the franchisor's side. Similarly, the idea that there is moral hazard at least on the tenant's side in sharecropping has been supported empirically in studies by Alston and Higgs (1982), Alston, Datta, and Nugent (1984), and Allen and Lueck (1993), among others. Finally, modelling sharing arrangements as resulting from the interaction of two input providers subject to incentive problems is consistent with the way individuals involved in these types of agreements view their relationship. For example, in Lafontaine (1992b), franchisors often said that they use royalties on sales in their franchise contract to harmonize the goals of both parties to the contract and to provide better incentives. Our goal in this article is to extend the existing work on contractual arrangements and double-sided moral hazard to show that even a simple model of this type can account for many of the stylized facts that characterize the payment schedules specified in these contracts.

The article is organized as follows. In the next section, we briefly discuss the available evidence and document, in several of the arrangements mentioned above, (a) a tendency to use linear payment schedules, (b) the relative uniformity of contract terms across agents, and (c) the stability of contract terms over time or as the number of agents increases. In Section 3 we argue that many of these contractual arrangements involve the provision of effort by more than one party and can, thus, be modelled in a double-sided moral hazard framework. We then develop such a simple model of contractual relationships. With risk-neutral parties, we show that the optimal contract involves a strictly positive revenue-sharing component and can be implemented via a linear scheme. While the single-sided moral hazard literature has focused on the trade-offs between risk sharing and efficient production to derive optimal linear contracts under special assumptions on probability distributions and utility functions, our analysis shows that the insurance motive need not be invoked at all to obtain revenue sharing and linearity of contracts. We conclude Section 3 by showing that under certain functional form assumptions, the optimal share parameter will be independent of the scale of operations and of the cost of effort of the two parties to the contract.

In Section 4 we extend our model to the case of multiple agents. We show that under appropriate specifications, and consistent with our earlier results, the optimal share parameter can be invariant across different agents in different markets. Moreover, the share parameter does not vary with the number of agents the principal contracts with. We conclude that our model is consistent with the kind of uniformity and stability of contracts that we observe. In contrast, much of the existing literature on the topic specifically implies that contracts should be tailored to the particulars of the contracting parties. Concluding remarks are found in Section 5.

It is sometimes argued that contract uniformity and stability result largely from legal constraints on contract term differentiation across agents. However, the data from Allen and Lueck (1993) show that landowners and tenants can and do choose a variety of cropsharing rules. Still, the vast majority (92% of them) choose to share output either on a 50/50, 40/60, or one-third/two-thirds basis. The tendency to use one of these three division rules in sharecropping clearly is not linked to legal constraints. Similarly,

Sappington (1991), and Romano (1994). Finally, recent work on franchising by Lafontaine and Bhattacharyya (forthcoming), Lutz (forthcoming), and Mathewson and Winter (1994) is cast within a double-sided moral hazard context.

Lafontaine (1992b) presents survey evidence suggesting that legal restraints are not the main motivation behind the uniformity of contracts in business-format franchising. McAfee and Schwartz (1994) advance further arguments against this explanation.

Other possible explanations for the lack of highly customized contracts include the high transactions costs of designing many different contracts (as Holmström and Milgrom (1987) and Pittman (1991) point out), the high administrative costs associated with differentiation (as noted by Holmström and Milgrom (1987) and Lafontaine (1992b)), and the potential for franchisor opportunism *ex post* in a context of downstream competition, which makes contract variation costly (see McAfee and Schwartz (1994) for a formal analysis of this point). While we agree that such cost arguments are important, our model is meant to demonstrate that another important type of explanation exists for the lack of contract customization. Our model emphasizes the fact that the benefits from differentiating contract terms across franchisees, and as circumstances change, may not be very large. In other words, even if the costs of differentiation were low, our model suggests that the benefits may be too small to make contract term customization worthwhile.

2. A survey of the current evidence on contract terms

■ Much of the empirical literature on contractual arrangements has been concerned with the circumstances under which certain types of contracts will arise, for example, with the incidence of sharecropping versus fixed-wage and fixed-rental contracts,[2] or with the use of franchising versus company ownership in business-format franchising,[3] or with contractual choice in the gasoline retailing industry (see Shepard (1993) and Slade (forthcoming)). Comparatively little attention has been given to the determinants of the actual terms of the contract, by which we mean those components of the contract that define the monetary obligations of the parties.[4] The few existing studies on contract terms have focused either on sharecropping (namely Chao (1983), Jodha (1984), Roumasset (1984), and Allen and Lueck (1993)) or franchising (Lafontaine (1992a, 1993), Sen (1993), and Lafontaine and Shaw (1994)). The patterns that emerge from this literature are that (a) payment rules tend to be simple and often linear, (b) in many cases, the same contract terms are used across numerous principal-agent pairs or across all agents by a given principal, and (c) contract terms are relatively stable over time or as the number of agents increases. These are the phenomena that our model focuses on. Before turning to the model, we briefly review the existing evidence and provide some new data related to these issues.

□ **The use of simple, often linear contracts.** The evidence concerning the popularity of linear payment rules is rather extensive. Several authors, including Arrow (1985), McAfee and McMillan (1987), Holmström and Milgrom (1987), and Milgrom and Roberts (1992), have noted this tendency toward relatively simple, and often linear, rules rather than the complex, nonlinear agreements predicted by much of the principal-agent literature. Linear pricing rules have been found in a number of diverse areas such as, but not limited to, sales force compensation, sharecropping, leasing arrangements, author's fees, legal fees, licensing agreements, commercial real estate rental fees, and

[2] See, for example, Allen and Lueck (1992), Alston, Datta, and Nugent (1984), Alston and Higgs (1982), Chao (1983), and Rao (1971).

[3] Notable contributions include Brickley and Dark (1987), Lafontaine (1992a, 1993), Martin (1988), and Norton (1988).

[4] In other words, we use this terminology to refer only to the monetary terms of the contract, such as royalty payments and fixed fees, as opposed to more qualitative contractual terms such as exclusive territories or covenants not to compete.

franchising.[5] This has prompted some authors to examine conditions under which linearity will be optimal in the standard principal-agent framework, while others have used it to restrict their analyses to linear rules only without examining whether linearity is optimal under the circumstances considered.[6]

When contracts involve nonlinear payments, these often take the form of minimum payment requirements within otherwise linear contracts. (See Masten (1988) on this issue.) For example, in Lafontaine (1992b), 40 of the 123 franchisor respondents indicated that they impose minimum royalty payments, in addition to their usual percentage rates and franchise fees. Minimum rental fees are also very frequent in commercial real estate contracts involving otherwise proportional rental fees. (See Urban Land Institute (1985).) We come back to this issue in Section 3. For the moment, we note that contracts are often linear, and that in those cases where they are not, mechanisms used to introduce nonlinearity are rather simple.

□ **The uniformity of contract terms.** The relative uniformity of contract terms across principal-agent pairs was first noted in the context of sharecropping arrangements. The propensity of sharecropping contract terms to remain relatively constant, at one-half, within and across regions as well as over time, was one of the "stylized facts" Newbery and Stiglitz (1979) suggested that theories of sharecropping needed to explain.[7] Recent studies have challenged the universality of this claim (see, for example, Alston and Higgs (1982), Roumasset (1984), Jodha (1984), and Allen and Lueck (1993)). Still, the preponderance of evidence is that sharecropping contract terms are fairly uniform, and that 50/50 splits remain very common.[8]

Contract terms can also be uniform in the sense of being the same for all agents who contract with a given principal, while allowing different principals to use different contract terms. In business-format franchising, for example, authors have noted how franchisors tend to use the same royalty rate and franchise fee combination with all of their franchisees (see Murrell (1983), Dnes (1992), Lafontaine (1992a, 1992b), and Sen (1993)).[9] We examined in detail the fees levied by a sample of 54 franchisors as described in their disclosure documents.[10] Table 1 summarizes the three main types of fees levied by these firms.[11] It shows (1) that the terms of the contract are often uniform

[5] See, for example, some of the articles above, as well as Caves, Crookell, and Killing (1983) on licensing agreements, Lafontaine (1992b) on franchising, Masten and Snyder (1993) on equipment leasing, and Coughlan and Narasimhan (1992) on sales force compensation.

[6] See, for example, McAfee and McMillan (1987), Holmström and Milgrom (1987), and Rogerson (1987) for examples of the first kind and Stiglitz (1974), Mathewson and Winter (1985), Gallini and Lutz (1992), and Slade (forthcoming) for examples of the second kind.

[7] As noted by Allen (1985), the words for sharecropping in French and Italian, respectively *métayage* and *mezzadria,* mean dividing in half.

[8] Chao (1983) finds that 50/50 splits were standard for over 2,000 years in China. Reid (1973) and Binswanger and Rosenzweig (1984) note that uniform output-splitting rules can hide much variation in other contractual provisions (e.g., input costs sharing). Allen and Lueck (1993) find that input costs are either not shared or shared the same way as output in their cropsharing contracts.

[9] U.S. Department of Commerce (1988) defines "business format" franchising as relationships where franchisors sell whole ways of doing business. Examples include restaurants and business and employment services. No royalties are collected in "traditional" franchising (car dealerships, soft-drink bottlers, and gasoline stations), as these franchisors obtain revenues from selling inputs to franchisees.

[10] Disclosure documents are statements that the Federal Trade Commission requires franchisors to make available to inquiring or potential franchisees. They must, among other things, contain information about all of the fees the franchisee will have to incur. We sent a request for disclosure documents to 598 franchisors. Only 54 of them complied.

[11] Input sales at a markup from franchisors to franchisees, another potential source of revenues for franchisors, are not covered in Table 1 because (1) they are not used much in business-format franchising, due to the *Siegel et al.* v. *Chicken Delight, Inc.* decision, and (2) when used, they are the same for all franchisees in the system.

TABLE 1 Summary of the Fees in 54 Disclosure Documents Collected from Franchisors in 1989

Franchise fee		
Single fee		19
Single fee	17	
None (including deposits only)	2	
Multiple fees		35
As a function of market potential	10	
Special fee for area development agreements	10	
Different franchise options	6	
Discounts for additional units	6	
Conversion discounts	2	
No explanation	1	
Total		54
Royalty rate[a]		
Single rate		41
Single rate	35	
With minimum payment required	6	
Multiple rates		13
Sliding scale	6	
Reduced rate for early year(s)	4	
Special rate for area development agreements	1	
Increasing scale	1	
Special rates in some regions (within U.S.)	1	
Total		54
Advertising fee[b] (excluding initial opening promotional fees)		
Single fee		44
Single rate (% of sales)	16	
Single rate stated as a minimum requirement	13	
None listed	8	
Single rate stated with minimum $ payments	5	
Single rate stated as a maximum requirement	1	
Single rate stated with maximum $ payments	1	
Multiple fees		3
Different rates across different markets	1	
Fee is a function of sales and unit size	1	
Minimum and maximum rates stated	1	
Other type of fee		7
Form of advertising specified (instead of cost)	4	
Fixed monthly payments (with built-in increases)	2	
Payment set by local franchisee group	1	
Total		54

[a] Input sales at a markup are not considered as a separate category in this table, despite the fact that they can be a substitute for royalties. The requirements to buy inputs from the franchisor or from approved suppliers were found to be small and basically constant across all franchisees in a chain.

[b] Including national, regional, and local requirements, but excluding grand opening expenses.

across all franchisees in a chain and (2) that franchise fees are more variable than royalty or advertising rates: 35 of the franchisors mentioned a number of possible franchise fees, while only 13 and 3 did so for the royalty rate and the advertising rate respectively.[12] Moreover, Table 1 establishes that there are different rationales behind

[12] The franchise fee apparently adapts more to market potential than surveys from the trade literature suggest. For example, about 20% of *Entrepreneur*'s 1990 "Franchise 500" franchisors indicate a range for their franchise fee or say it varies, as compared to 60% of franchisors in Table 1. For 21 of the 50 franchisors

variations in franchise fees and variations in royalty and advertising rates. Most of the variation in franchise fees is related to the market potential of the unit (26 cases out of 35). Multiple royalty rates, on the other hand, occur mostly when the franchisor chooses to use a sliding (or increasing) scale, or when she reduces the fees over the first few years of operation.[13] These different royalty rates typically are offered to all franchisees entering into the franchise contract at a given time. Of these, only the sliding and increasing scale clauses can be seen as ways to adjust for differences in market potential across outlets. Finally, Table 1 shows that the use of a variety of advertising fees is mostly due to the franchisor's desire to maintain flexibility in setting these fees.[14] In fact, advertising rates typically vary over time during the period of the contract, not across franchisees at a point in time.

There is further evidence of uniformity of contract terms across agents in other areas, such as leasing (see Kaysen (1956) and Masten and Snyder (1993)) and, to some extent, licensing (see Contractor (1981) and Caves, Crookell, and Killing (1983)).[15] This is not to say that we always find the same contract terms, but rather that in many different contexts, we find much less customization of contract terms across different principal-agent pairs than one would expect under presently available explanations for these types of contracts.

□ **The stability of contract terms.** There are only a few cases where researchers have been able to document the evolution of the terms of various contracts over time or as the number of agents increases. In the case of franchising contracts, the existing evidence suggests a fairly large degree of persistence or stability in contract terms, but especially in the royalty rates, over time (see Banerji and Simon (1992), Lafontaine (1992b, 1993), and Lafontaine and Shaw (1994)). The empirical evidence on sharecropping also supports the notion that the share parameter in these contracts has been remarkably stable over time, while other aspects of the contract seem to have been modified to a much larger degree (see, e.g., Chao (1983)). Finally, with respect to leasing contracts, Kaysen (1956) notes that there were no changes in monthly charges or in unit charges for the vast majority of United Shoe Machinery's machines over the 1922–1946 period. In all of these cases, the observed degree of stability is much greater than one would expect it to be under current theories. We believe that this aspect of these contractual relationships also warrants further study.

3. Double-sided moral hazard: the single-agent case

■ In this section we develop a simple model of contractual arrangements based on double-sided moral hazard in the case of a single principal-agent pair. We show that under some circumstances, this simple model can account for a number of the stylized facts noted above. More specifically, the model shows that linear contracts can be optimal, and that the optimal contract terms may well be independent of such things as the scale of operation or cost of effort of the parties to the contract. In that sense,

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included in both samples, the *Entrepreneur* survey gave a single (the most "standard") fee when the disclosure document revealed the possibility of different fees.

[13] Note that, compared to the incidence of varying franchise fees, the incidence of varying royalty rates is well represented in published surveys: About 14% of the franchisors in the *Entrepreneur* survey indicated a variable royalty rate, which is very close to our estimate of 18%.

[14] Contracts often stipulate minimum advertising rates (13 cases) so the franchisee can spend more on local advertising if he wishes. (See Ozanne and Hunt (1971) for a sample clause.) Franchisors specify maximum rates when they want the opportunity to modify the advertising contribution during the contract period.

[15] Pittman (1991) also discusses the uniformity of contract terms between railroads and shippers for sidetrack construction.

our model suggests that the benefits of tailoring contract terms may be quite limited, if not zero.

Much of the evidence surveyed above was about business-format franchising contracts. For that reason, and also because this allows us to describe the model in more concrete terms, we formulate our model in the context of the franchise relationship. It should be clear, however, that our conclusions apply to any type of joint production arrangement where two parties each contribute some unmarketed input to the production process. Most of the contractual relationships discussed above can be, and have been, characterized in this way.[16]

□ **The model.** In business-format franchising, the franchisor is typically responsible for providing training and general support to her franchisees. She is also the one in charge of promoting and advertising the chain nationally, and more generally of developing and maintaining the value of the trade name. The franchisee, on the other hand, is responsible for managing the outlet on a day-to-day basis. This involves hiring and supervising employees, keeping track of local needs, and overseeing local advertising. Both sets of inputs affect the performance of the outlet. However, the intensity of efforts devoted to such activities is not easily monitored by parties other than the individual providers of the effort. We model this by assuming that the downstream production function has two arguments, the franchisee's effort level, denoted by e (for franchis"ee"), and the franchisor's, r.[17] We use a production function

$$\tilde{X} = f(e, r) + \tilde{\epsilon}, \tag{1}$$

where $\tilde{X}$ is the total monetary return produced and $\tilde{\epsilon}$ is a random term with mean zero and variance σ^2. We also assume that the realization of $\tilde{\epsilon}$ is unobservable to both parties and that the effort levels are unverifiable. As a result, contracts based on either e or r are not feasible: any enforceable contract has to be based on the downstream output level.[18]

In order to focus more clearly on the issue of joint production, we abstract from risk-sharing concerns and assume that both parties are risk neutral.[19] We make this assumption to highlight the fact that revenue sharing as an outcome need not depend on the presence of risk aversion. However, it is important to note that introducing risk aversion serves only to bolster the case for revenue sharing.

We take $f(\cdot, \cdot)$ to be a standard neoclassical production function. Letting subscripts denote partial derivatives, this implies that f_e and f_r are positive, that f_{ee} and f_{rr} are negative, and that f_{er} is positive. We further assume that $f(0, r) = 0$ and $f(e, 0) = 0$. This assumption simply emphasizes the team production aspect of the production technology by stating that both inputs are required for any production to occur. Finally, we assume that the franchisor's and the franchisee's disutility-of-effort functions are given

[16] See, for example, Reid (1977), Eswaran and Kotwal (1985), and Allen and Lueck (1993) for such a characterization of sharecropping arrangements, Contractor (1981) on licensing arrangements, and Masten and Snyder (1993) on equipment leasing.

[17] An alternative formulation, which would describe mostly "traditional franchising," would be to have the franchisor sell inputs to franchisees which they use in generating downstream output. However, one would then have to assume that the quality, for example, of the goods sold is unobservable, to preserve the franchisor moral hazard problem.

[18] Since there are two sources of effort provision, we do not need to make the assumption of nonshifting support that is required in the standard moral hazard literature.

[19] This assumption is consistent with the fact that some franchisors use a fixed-rent contract. Lafontaine (1992a) found that 37 of the 548 franchisors in her sample used this type of contract. Since they assign all the risk to the franchisee, these contracts can be optimal only if the franchisee is risk neutral or if risk is not an important factor in the determination of the contract terms.

by $U(r)$ and $V(e)$ respectively, both of which we take to be increasing and convex in effort. Since neither effort level is verifiable, any enforceable contract has to be based on the downstream output level. Using $\omega(\cdot)$ to denote the franchisor's share of the monetary return generated, the Pareto-optimal program for this problem may be written as

$$\max_{\omega(\cdot),e,r} \{E[\omega(f(e, r) + \tilde{\epsilon})] - U(r)\} \tag{2}$$

subject to

(i) $$\frac{\partial}{\partial r}E[\omega(f(e, r) + \tilde{\epsilon})] = U'(r)$$

(ii) $$\frac{\partial}{\partial e}E[((f(e, r) + \tilde{\epsilon}) - \omega(f(e, r) + \tilde{\epsilon}))] = V'(e)$$

(iii) $$E[(f(e, r) + \tilde{\epsilon}) - \omega(f(e, r) + \tilde{\epsilon})] - V(e) \geq k,$$

where k stands for the franchisee's reservation utility level. Constraints (i) and (ii) represent the franchisor's and the franchisee's incentive-compatibility constraints respectively, and (iii) is the franchisee's individual-rationality or participation constraint.

Theorem 1. Without loss of generality, the optimal sharing rule can be represented by a linear contract.[20]

Proof. The intuition for the proof is as follows. Let the slope of the optimal sharing rule at the optimum be β. Then, by choosing a linear rule with slope β and adjusting the fixed fee accordingly, exactly the same incentives and total payments can be achieved as with the optimal sharing rule assumed. See the Appendix for a full proof.

Note that while a linear contract implements the second-best levels of effort for both parties, it is not in any way the unique contract that achieves this end. In particular, a linear contract with a minimum royalty commitment—a type of contract that, as we noted earlier, is used quite frequently in franchising and in commercial leasing—can also implement the second-best effort levels given the additive disturbance structure assumed here. This is because a minimum royalty amount, so long as it is strictly less than the expected royalty amount under the optimal linear scheme, essentially plays the same role as the fixed fee: it affects only the franchisee's participation constraint and not the marginal incentives embedded in the incentive-compatibility conditions.

We should also point out that the result above is dependent on the particular structure that we have imposed on the output-generation process. An unrestricted production function of the form $\tilde{X} = g(e, r, \tilde{\epsilon})$ would not necessarily lend itself to a solution representable by a linear contract.[21] What is important in our formulation to obtain linearity as a solution is the notion that realized output must be a garbling of some level of "intrinsic output" given by $f(e, r)$, where the extent of the garbling is independent of the individual levels of e and r. The additive formulation that we adopt is merely for convenience and is inessential for our results. The proof of Theorem 1, in particular, can be extended rather straightforwardly to the case of

$$\tilde{X} = a(\tilde{\epsilon})f(e, r) + b(\tilde{\epsilon}),$$

where the functions $a(\cdot)$ and $b(\cdot)$ are normalized to have $E(a(\tilde{\epsilon})) = 1$ and $E(b(\tilde{\epsilon})) = 0$. Further, the fact that $f(e, r)$ enters linearly in this more general version is not a real

[20] Romano (1994) independently derived a version of this result.

[21] We thank Michael Whinston for a nice example illustrating this point.

restriction, as this is simply a matter of normalizing the level of "intrinsic output." However, despite our restrictions, we think our characterization of the joint production process is quite reasonable when the individual inputs are substitutes for each other.

Given that the optimal outcome can be implemented via a linear contract, and since the random term attached to f does not affect results for the slope of the contract, we can relabel variables so that they now stand for their respective expected values. The franchisor's problem can then be rewritten more simply as

$$\max_{\beta,F,e,r} \{F + \beta \cdot f(e, r) - U(r)\} \tag{3}$$

subject to

$$\text{(i)} \qquad \beta f_r(e, r) = U'(r)$$

$$\text{(ii)} \qquad (1 - \beta) f_e(e, r) = V'(e)$$

$$\text{(iii)} \qquad (1 - \beta) f(e, r) - F - V(e) \geq k,$$

where F is a fixed fee and β is a royalty rate on the (dollar) output, both of which are paid by the franchisee to the franchisor in exchange for the franchise rights. The Lagrangian for this problem is

$$\begin{aligned} \mathcal{L} = F + \beta f - U(r) - \lambda[U' - \beta f_r] - \mu[V' - (1 - \beta) f_e] \\ - \nu[k - (1 - \beta) f + F + V(e)]. \end{aligned} \tag{4}$$

The first-order conditions for the optimization are as follows.[22]

(i) With respect to F, $1 - \nu = 0$, which implies $\nu = 1$. Hence the franchisee's individual-rationality constraint must be binding, i.e.,

$$(1 - \beta) f(e, r) - F - V(e) = k. \tag{5}$$

This implies that there are no rents left downstream.[23]

(ii) With respect to e,

$$\beta f_e + \lambda[\beta f_{re}] = \mu[V'' - (1 - \beta) f_{ee}] + \nu[(1 - \beta) f_e - V'] = 0. \tag{6}$$

The last term in this condition is equal to zero given the franchisee's incentive-compatibility constraint, so we have

$$\beta f_e + \lambda[\beta f_{re}] - \mu[V'' - (1 - \beta) f_{ee}] = 0. \tag{7}$$

(iii) With respect to r,

$$[\beta f_r - U'] - \lambda[U'' - \beta f_{rr}] + \mu[(1 - \beta) f_{er}] + \nu(1 - \beta) f_r = 0, \tag{8}$$

[22] We assume that $f(\cdot, \cdot)$ is sufficiently concave and that $U(\cdot)$ and $V(\cdot)$ are sufficiently convex so that the second-order conditions hold.

[23] We could allow the franchisee to earn "rents" in our framework by letting k denote a utility level above the franchisee's reservation utility level by an amount a, where a is an efficiency wage. Kaufmann and Lafontaine (1994) make the case that McDonald's franchisees on average earn economic rents, and that these are a mechanism for contractual self-enforcement (as in Klein (1980)) given franchisee wealth constraints. See also Mathewson and Winter (1985) on this.

where the first term in brackets is equal to zero given the franchisor's incentive-compatibility constraint. Since $\nu = 1$, we can rewrite (8) as

$$-\lambda[U'' - \beta f_{rr}] + \mu[(1 - \beta)f_{er}] + (1 - \beta)f_r = 0. \tag{9}$$

(iv) With respect to β,

$$f + \lambda f_r - \mu f_e - \nu f = 0, \tag{10}$$

which, given $\nu = 1$, can be rewritten simply as

$$\lambda f_r = \mu f_e. \tag{11}$$

From these conditions, we find that the multipliers for the incentive-compatibility constraints, λ and μ, must be nonzero. For $\lambda f_r = \mu f_e$ to hold, given that we have assumed that $f_r, f_e > 0$, it must be that λ and μ are both nonzero, or that they are both equal to zero. If the latter were true, then from (7) and (9) we have that $\beta f_e = 0$ and $(1 - \beta)f_r = 0$. But with $f_r, f_e > 0$, these two conditions cannot hold simultaneously. Hence it must be that λ and μ are both strictly nonzero.

Relating the first-order conditions to the case where there is moral hazard only on the franchisee's side, i.e., where there is no notion of franchisor effort (as in the standard moral hazard literature), then $f_r = 0$, $f_{rr} = 0$, and $f_{er} = 0$, whereas $f_e > 0$. From (11), it must be that $\mu = 0$. But then from (7), $\beta f_e = 0$, which implies that $\beta = 0$. This is the usual result: under risk neutrality, the agent who provides the only unobservable input becomes the single residual claimant. In other words, in this case the franchisee does not share his income at all with the franchisor. Similarly, one finds from the above equations that if the franchisor is the only one providing an unobservable input, she becomes the sole residual claimant, i.e., $\beta = 1$. For the franchisee to accept this contract then requires that the franchise fee be negative, i.e., that the franchisee be paid a fixed wage. However, with double-sided moral hazard, we have the following result.

Corollary 1. With double-sided moral hazard the optimal contract cannot have $\beta = 0$ or $\beta = 1$. In other words, output must be shared.

Proof. From the incentive-compatibility constraints, we have

$$\beta f_r(e, r) = U'(r) \quad \text{and} \quad (1 - \beta)f_e(e, r) = V'(e). \tag{12}$$

From the participation constraint, we know that $f(e, r)$ must be positive, otherwise F would have to be negative. But then the franchisor earns negative profits, in which case she is better off not contracting with the franchisee.[24] For $f(e, r) > 0$, it must be, from our team production assumption, that both e and r are positive. Hence, $U'(r)$ and $V'(e)$ must also both be positive. Then, if β were either 0 or 1, one of the incentive-compatibility conditions above would not be satisfied. As a result, β must be strictly between 0 and 1. *Q.E.D.*

Note that the incentive-compatibility conditions on the two parties imply that

[24] In other words, the franchisor's participation constraint, which was not explicitly stated in the program, but which requires that the franchisor obtain a nonnegative return, rules out her sustaining expected losses.

$$\beta = \frac{U'(r)/f_r(e, r)}{V'(e)/f_e(e, r) + U'(r)/f_r(e, r)}. \tag{13}$$

That is, for a given level of β, the effort levels adjust so that the contribution of the franchisor to the sum of marginal disutilities weighted by respective productivities is equal to the royalty rate. The constrained Pareto program can, thus, be viewed as imposing an efficiency constraint that embodies the utility cost of productive effort by each party at the margin. The optimal royalty rate is the one that maximizes the franchisor's utility subject to this efficiency constraint and to the reservation utility constraint of the franchisee. Using the first-order conditions laid out in equations (7), (9), and (11), we can get an expression for the optimal level of β, denoted by β^*:

$$\beta^* = \frac{f_r^2[(1-\beta^*)f_{ee} - V'']}{f_e^2[\beta^* f_{rr} - U''] + f_r^2[(1-\beta^*)f_{ee} - V'']}, \tag{14}$$

where all quantities on the right-hand side are evaluated at the optimal levels for e and r.[25] While this equation can, in principle, be solved for β^*, the resulting expression fails to yield any intuition behind the factors determining the optimal royalty rate without further structure on the production function and the disutility functions. In particular, we are unable to obtain simple, closed-form expressions for the levels of the optimal efforts on the part of the two parties without greater amount of structure. As a result, we now explore the solutions to the problem above with restricted functional forms.

□ **Cobb-Douglas production and exponential disutility functions.** The double-sided moral hazard model has particularly appealing solutions when the technology of joint production is taken to be of the Cobb-Douglas form[26] and the disutility-of-effort functions are restricted to be from the exponential family, that is,

$$f(e, r) = Ke^{\gamma}r^{\alpha}, \tag{15}$$

where $0 < \gamma, \alpha < 1$, and $U(r) = \delta^R r^n/n$, $V(e) = \delta^E e^m/m$, with $m \geq 1$, $n \geq 1$. We view the parameters δ^E and δ^R as characteristics representing how costly individual effort is for the franchisee and the franchisor respectively, and refer to them as disutility-of-effort parameters. With these functional forms we have the following result.

Theorem 2. With Cobb-Douglas technology and exponential disutility-of-effort functions, the optimal sharing parameter is independent of the scale parameter, K, and of the disutility-of-effort parameters, δ^E and δ^R.

Proof. Substituting the relevant partial derivatives into (14), we have[27]

$$\frac{\beta^*}{(1-\beta^*)} = \frac{\alpha^2 e^2}{\gamma^2 r^2} \frac{[(1-\beta^*)\gamma(\gamma-1)Ke^{\gamma}r^{\alpha} - (m-1)\delta^E e^m]}{[\beta^*\alpha(\alpha-1)Ke^{\gamma}r^{\alpha} - (n-1)\delta^R r^n]}. \tag{16}$$

For this to yield a solution for the optimal value of β, we must replace e and r with

[25] Intermediate steps are available from the authors.

[26] Because substitution among inputs is our main focus, we want to analyze production functions parameterized by the elasticity of substitution. Of those, only the Cobb-Douglas satisfies our assumption that both inputs are needed for nonzero production.

[27] For the second-order conditions to hold, we must have $\alpha + \gamma < m, n$.

their optimal values, which themselves depend on β^*. The incentive-compatibility constraints are

$$\alpha\beta^* K e^{\gamma} r^{\alpha} = \delta^R r^n \quad \text{and} \quad \gamma(1 - \beta^*) K e^{\gamma} r^{\alpha} = \delta^E e^m. \tag{17}$$

Substituting these expressions into (16) and simplifying the expressions yields the following expression for β^*:[28]

$$\beta^* = \left[1 + \sqrt{\frac{\gamma(n - \alpha)}{\alpha(m - \gamma)}}\right]^{-1}. \tag{18}$$

In other words, the optimal share parameter β^* is a function of the exponents in the production function and in the disutility-of-effort functions, and only those. It does not depend on the δs or on K. *Q.E.D.*

Having solved for the optimal royalty rate β^*, the franchise fee F^* will be chosen to extract all downstream profits. This implies that

$$F^* = (1 - \beta^*) f(e^*, r^*) - V'(e^*) - k = (1 - \beta^*) K (e^*)^{\gamma} (r^*)^{\alpha} - \frac{\delta^E (e^*)^m}{m} - k. \tag{19}$$

So, while the royalty rate is independent of K, the franchise fee is positively related to K.

The fact that the optimal β is independent of the scale parameter under our specification implies that the royalty rate could very well be the same across units of very different sizes operating in different (geographical) markets. But since the franchise fee is selected to make the franchisee's participation constraint binding in any market, it would vary with both the scale of operations and the individual franchisee's cost-of-effort parameter. Consequently, we would expect to observe more variability in this fee across markets (and agents). This is consistent with the evidence summarized in Table 1.

Second, our result implies that the share parameter/royalty rate will not depend on the level of market power available to the business partnership in a particular market. This can be demonstrated by a slight modification of our notation. The revenue function can be written as $p(Q) \cdot Q(e, r)$, where $p(Q)$ is the expected inverse demand function corresponding to the quantity level Q produced. Note that this formulation encompasses an oligopoly or monopolistically competitive structure, with $p(Q)$ denoting the residual inverse demand curve faced by each outlet. The Pareto problem is then composed of two parts: the determination of the optimal scale of production (Q), followed by the determination of the optimal contract terms. For any given level of $p(Q)$, the derivation above shows that the optimal β remains the same. That is, the determination of the optimal sharing rule is independent of the determination of the scale of production. As a result, the level of market power of an individual outlet affects its preferred level of production and ipso facto the level of the franchise fee. The share parameter, however, is solely determined by the parameters α, γ, m, and n as before. Hence we have proved the following result.

Corollary 2. With Cobb-Douglas technology and exponential disutility-of-effort functions, the optimal share parameter is independent of the characteristics of the aggregate demand curve and the number of competitors in the market.

[28] Detailed derivations are available from the authors.

While these results are consistent with the observed uniformity of contract terms noted earlier, it is important to examine the extent to which our conclusions remain valid under more general specifications. We now turn to this issue.

□ **Robustness.** In this subsection we show that our results that the royalty rate may be independent of the scale of operations and of the disutility-of-effort parameters of the franchisee and franchisor are fairly robust. First, restricting the disutility-of-effort functions to be of the same functional form (that is $m = n$),[29] we find that the independence with respect to the scale of operation, K, is very robust: this result holds for all homogeneous production functions. More specifically, we have

Theorem 3. When the technology of joint production is homogeneous and the franchisee and franchisor have exponential disutility-of-effort functions that differ only with respect to the values of δ^E and δ^R, the optimal share parameter β^* is independent of the scale of operations. Furthermore, β^* depends on the ratio of the disutility-of-effort parameters and not on their individual values.

Proof. With a production function that is homogeneous of degree p, we can rewrite our Pareto program as follows:

$$\max_{r,\theta,\beta} \left\{ r^p \left[K \cdot g(\theta) - \frac{\delta^E}{m} \theta^m r^{m-p} - \frac{\delta^R}{m} r^{m-p} \right] \right\} \tag{20}$$

subject to

$$K\beta r^{p-1}[pg(\theta) - \theta g'(\theta)] = \delta^R r^{m-1} \tag{21}$$

$$K(1 - \beta) r^{p-1} g'(\theta) = \delta^E r^{m-1} \theta^{m-1}, \tag{22}$$

where $\theta = (e/r)$ and the production function $f(e, r)$ can be written as $Kr^p g(\theta)$ by virtue of its homogeneity.

Dividing (21) by (22) gives

$$\frac{\beta}{(1-\beta)} \cdot \frac{pg(\theta) - \theta g'(\theta)}{g'(\theta)} = D\theta^{1-m}, \tag{23}$$

where $D = \delta^R/\delta^E$. Thus the value of β is determined from the constraints to be independent of r. Solving for β from above and substituting in (21) gives

$$r^{m-p} = \frac{K}{\delta^E} \theta^{1-m} g'(\theta), \tag{24}$$

which, when substituted into the objective function, yields

$$\max_{\theta} \left\{ K \left(\frac{K}{\delta^E} \right)^{p/(m-p)} \left[(\theta^{1-m} g'(\theta))^{p/(m-p)} \left(g(\theta) - \frac{g'(\theta)}{m} (\theta + D\theta^{1-m}) \right) \right] \right\}. \tag{25}$$

[29] We need this restriction because our assumption that both inputs are necessary for production is not satisfied by a general homogeneous production function.

Note that the optimal value of θ, θ^*, does not depend on K and depends on the disutility-of-effort parameters only through their ratio, D. Since, from (23), β^* is a function only of D and θ, it follows that β^* is also independent of K. *Q.E.D.*

The fact that β^* is independent of K shows that our earlier conclusion about the insensitivity of the optimal royalty rate to the scale of operation or to the extent of market competition continues to hold in this more general setting. However, in this case, the optimal β varies with the ratio of the δs. In order to determine the sensitivity of the optimal β to variation in this ratio, we examine numerically the solutions to our Pareto program using a constant elasticity of substitution (CES) production function.[30] That is, we take

$$f(e, r) = K[ae^{\rho} + (1 - a)r^{\rho}]^{h/\rho}, \tag{26}$$

where $0 < a < 1$ is the input intensity parameter, $-\infty \leq \rho \leq 1$ is the substitution parameter, and h is a returns-to-scale parameter, with $h < 1$ implying decreasing returns to scale. Note that this reduces to a linear function when h, $\rho = 1$, and it becomes a Cobb-Douglas function when $\rho = 0$.[31] For the disutility-of-effort functions, we continue to assume exponential functions with $m = n$.

Table 2 summarizes the results of our numerical estimations. The first column gives the value of ρ, which we assumed to be relatively small, as the empirical literature on the CES suggests it should be.[32] The next column shows the ratio of the δs, which we vary from .5 to 2. The next two columns give the optimal royalty rate and franchise fee, respectively. They show, consistent with our earlier discussion, that the royalty rate varies much less than the franchise fee does. The last two columns give the value of the objective function and the lost franchisor profits that result when the royalty rate is not tailored to the specific parameters of the problem. We use as our base case $D = 1$, $m = n = 2$, and $a = .5$, which together imply $\beta^* = .5$. This is therefore the value of β that we impose to calculate the lost franchisor profits from not tailoring the contract in the last column of Table 2.[33]

The results in Table 2 show first that as long as ρ is greater than zero, the franchisor's share goes up as the franchisee's cost of effort increases relative to hers. In other words, efficiency here requires that we give more incentives to the owner of the relatively less costly input when the two are good substitutes for each other ($\rho > 0$). When ρ is smaller than zero, the franchisor's effort is not such a good substitute for the franchisee's. In an attempt to secure a sufficient level of franchisee effort, it is the share that goes to the franchisee that increases as the cost of his effort increases relative to the franchisor's.

But while the optimal β is affected by the relative cost of effort of the franchisor and the franchisee in Table 2, it is also noteworthy that the variation in β^* is quite small. In addition, the objective function around β^* is relatively flat, leading to only a slight loss in franchisor profits when the royalty rate is fixed at .5 instead of its optimal value. In that sense, we find that the benefit of customizing the share parameter to account for variations in the δs is quite small, so that such customization may not be worthwhile.

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[30] Note that the general CES function does not satisfy our assumption that both inputs are necessary for production.

[31] In that case $a \cdot h$ corresponds to the γ parameter, and $(1 - a) \cdot h$ the α parameter, of the Cobb-Douglas function.

[32] See, for example, Chung (1994) for a summary of the empirical literature on this subject.

[33] Similar results were obtained with $m = n = 3$. Changes in a required a different base comparison: For $a = .25$, for example, given the other parameter values, β^* was .64. Using this as the base value, the same qualitative results described in Table 2 held when a was set equal to .25.

TABLE 2 **The Effect of Variation in the Ratio of the Cost-of-Effort Parameters**

ρ	δ^F/δ^R	β^*	F^*	Optimal Franchisor Profits	Franchisor Profits Lost with β = .5
−.4	.5	.518	.129	.263	.07%
−.4	1.0	.500	.094	.188	.00%
−.4	2.0	.482	.067	.131	.07%
−.1	.5	.505	.131	.264	.01%
−.1	1.0	.500	.094	.188	.00%
−.1	2.0	.495	.066	.132	.01%
.1	.5	.494	.134	.266	.01%
.1	1.0	.500	.094	.188	.00%
.1	2.0	.506	.066	.133	.01%
.4	.5	.469	.139	.270	.18%
.4	1.0	.500	.094	.188	.00%
.4	2.0	.531	.065	.135	.18%

Note: Assumes $m = n = 2$ and $a = .5$.

We conclude that the optimal share parameter and the resulting franchisor profits are either independent of or rather insensitive to changes in the scale of operations, market competition, and variation in the relative cost of effort of the franchisee and the franchisor, making it likely that we would observe similar share parameters across principal-agent pairs facing rather different markets and circumstances.

4. Extending the model to multiple franchisees

■ With some modifications, our simple double-sided moral hazard model can be readily extended to the case of multiple agents or franchisees.[34] In doing so, we particularly want to focus on conditions needed to keep the optimal share parameter independent of an individual franchisee's market size and, possibly, other franchisee characteristics. In addition, we want to examine whether the share parameter is independent of the number of franchisees, N.

In considering the case of multiple franchisees, we first have to decide how to model the franchisor's disutility-of-effort function. We take effort to be of two types: franchisee-specific, or private effort, and chainwide, or public effort. The first type of effort encompasses such things as training, general support, consulting services, and monitoring activities that are unit-specific, while the second type includes services like developing brand names further via advertising, product development, and the like. Note that with multiple franchisees, it is no longer reasonable to treat the franchisor's cost of effort as being convex in total effort expended, since this would give rise to severe disadvantages to forming a chain in the first place: With rising marginal cost of effort, the marginal cost of opening a new outlet rises dramatically with the size of the chain. Given that most franchisors are corporate entities and not single individuals, it makes more sense to take the marginal cost of private franchisor effort to be constant.

[34] Our analysis is restricted to contracts that respect limited liability provisions and exclude the posting of bonds *ex ante*. Without such constraints, and ruling out the possibility of collusion among agents, Carmichael (1983) demonstrates that relative performance contracts can elicit first-best levels of effort.

The public effort, however, can be assumed to have increasing marginal costs in utility terms. We assume that such effort on the part of the franchisor goes to increase the total market potential of each franchisee through an enhancement of the scale parameter, K. In particular, we take the ith franchisee's production function to be of the form

$$K_i(r_0)\cdot f(e_i, r_i), \tag{27}$$

where $K_i(r_0)$ is an increasing and concave function, r_0 is the franchisor's public effort, and r_i is the franchisor's private effort at the ith location.

Denoting the ith franchisee's parameters by the subscript i, we can write the franchisor's maximization problem as

$$\max_{e_i, r_i, \beta_i, r_0} \sum_{i=1}^{N} \{K_i(r_0)\cdot f(e_i, r_i)\} - \sum_{i=1}^{N} \frac{1}{m} \delta_i^E e_i^m - \sum_{i=1}^{N} \delta^R r_i - C(r_0) \tag{28}$$

subject to

$$\text{(i)} \qquad \beta_i K_i(r_0) f_r(e_i, r_i) = \delta^R, \qquad i = 1, \ldots, N$$

$$\text{(ii)} \qquad (1 - \beta_i) K_i(r_0) f_e(e_i, r_i) = \delta^E e_i^{m-1}, \qquad i = 1, \ldots, N,$$

where $C(r_0)$ is an increasing, convex function denoting the cost of the public effort on the part of the franchisor. Note that the objective function above can be rewritten as

$$\max_{r_0} \left[\max_{e_i, r_i, \beta_i} \sum_{i=1}^{N} \left\{ K_i(r_0)\cdot f(e_i, r_i) - \frac{1}{m} \delta_i^E e_i^m - \delta^R r_i \right\} \right] - C(r_0). \tag{29}$$

From inspection of the above equation, given our concavity assumptions, it is clear that this problem can be solved in two stages. Thus, for any value of r_0, define $V_i(r_0)$, $i = 1, \ldots, N$ to be the value of the maximization program within the brackets, subject to the incentive-compatibility constraints above, and denote the optimal value of the solution variables to be $(e_i^*(r_0), r_i^*(r_0), \beta_i^*(r_0))$. Then the solution to the original problem is obtained from the following unconstrained maximization program:

$$\max_{r_0} \left[\sum_{i=1}^{N} V_i(r_0) \right] - C(r_0). \tag{30}$$

In other words, the solution to the multiple franchisee problem under this set of assumptions is exactly the same as if for the optimal level of r_0, each franchisor-franchisee pair problem is solved independently. Consequently, the results of the previous analysis apply in a straightforward fashion to the multiple-agent case. In particular, when the production technology is Cobb-Douglas with common coefficients (α, γ, m) across franchisees, we know from our earlier analysis that the optimal sharing rule must be independent of the scale parameters, K_i, and the disutility-of-effort parameters, δ_i^E. Also, given the separability of the problem, it is clear that N does not affect the optimal share parameter either. Hence we have the following result.

Corollary 3. With Cobb-Douglas production technology, constant marginal cost of private effort for the franchisor, and exponential disutility-of-effort functions for heterogeneous franchisees, the optimal share parameter is independent of market size or market competition, franchisee disutility-of-effort parameters, and the size of the franchise chain.

Note that, as before, the uniformity of the royalty rate across franchisees does not imply that the franchise fee is also constant. Rather, it will change, for example, with the market potential of the unit, as in fact it often does in reality.

By way of an interesting contrast, we also note that the insensitivity of royalty rates to the size of the market and to franchisee heterogeneity is not possible to obtain, for example, via models that view the franchise contract as a signal of franchisor quality. Although it is true that a high-quality franchisor, by setting a combination of a low franchise fee and a high royalty rate, can distinguish herself from a low-quality one (see, for example, Desai and Srinivasan (1990) and Gallini and Lutz (1992)), in general both the royalty rate and the franchise fee that she charges will depend on the characteristics of the markets she operates in. Even if the franchisor were constrained to charge the same rate across franchisees, under signalling this rate would be a function of the distribution of franchisee market sizes (and of the franchisees' productivity). Thus, any addition of a new franchisee, or loss of an existing one, would result in a change in the optimal royalty rate. With hidden action instead of hidden knowledge, the determination of the optimal royalty rate comes first, and the franchise fee acts as a residual chosen so as to satisfy each franchisee's participation constraint. As a result, incentive compatibility is satisfied with only the royalty rate determination. In signalling models, on the other hand, it is the royalty rate and franchise fee together that are responsible for sorting conditions to hold.

As before, the strong results of the Cobb-Douglas case with respect to franchisee heterogeneity do not go through for the case of general homogeneous production functions. If, however, the franchisees have identical constant marginal costs of effort, we can readily see what the earlier analysis yields as an implication. This is summarized below.

Corollary 4. With a homogeneous production technology, constant marginal costs of private effort for the franchisor, and identical franchisees with constant marginal costs of effort, the optimal share parameter is independent of market size or market competition, the size of the franchise chain, and is identical across franchisees.

Note that for the royalty rate to remain the same across franchisees, we now need the franchisees to be identical in terms of having the same disutility-of-effort parameter in addition to having a constant marginal cost of effort. However, our robustness analysis of the earlier section established that the variation in the optimal royalty rate and, especially, in the value of the franchisor's profits is not particularly responsive to reasonable variation in the franchisees' cost-of-effort parameters. As a result, we would expect the benefits of contract customization to be small in percentage terms in this case, too.

We should point out, finally, that our result on the independence of the optimal royalty rate from the number of outlets, N, has implications for optimal contracting under congestion and encroachment effects.[35] Consider, for example, the opening of a new franchised outlet that encroaches on the market potential of an existing outlet, i. Such encroachment would only affect the production plans and profits at the ith outlet through its effect on K_i, which, as we have already shown, does not affect the optimal

[35] Encroachment, which has become a contentious issue in franchising over the past few years, typically refers to the possibility that a franchisor, by opening a new outlet nearby or by creating competing franchise concepts, adversely and unduly affects the sales and profitability of existing franchised units. See Franchise Update (1994) for an account.

share parameter. Hence, our conclusion about the uniformity of royalty rates goes through even in the presence of encroachment and congestion externalities.

5. Conclusion

■ In this article we first established some stylized facts about the payment rules used in a number of revenue- and profit-sharing arrangements. In particular, we highlighted the widespread use of simple linear payment rules that are fairly uniform and stable. We also showed some evidence, however, that the fixed component of the contract tends to vary more than the share parameter does. We then developed a simple double-sided moral hazard model that could account for these features.

We found that the optimal second-best contract could be implemented via a linear contract. In that sense, this article provides a new and simple explanation for the preponderance of linear contracts. Moreover, we showed that with simple cost-of-effort functions, the share parameter would be constant across franchisees with different cost-of-effort parameters if the technology could be described (at least approximately) by a Cobb-Douglas production function. Similarly, different scales of operation at different locations would not require a change in the share parameter under this type of technology (and cost-of-effort functions) in our model. However, the model predicts that differences in the cost of effort across franchisees and in the size of the market for each outlet should lead firms to require different franchise fees. This we found to be consistent with our empirical evidence that upfront franchise fees are more variable than royalty rates, and in fact are often specifically stated in terms of market potential. Finally, we saw that the share parameter would not need to be altered as the size of the franchise chain increases if the technology is again well captured by a Cobb-Douglas function. Although our functional specifications are clearly restrictive, we also showed that relaxing them in various ways does not alter our conclusions much.

In general, we find this approach of modelling revenue- or profit-sharing arrangements based on double-sided moral hazard to be quite promising, primarily because of its simplicity and its accordance with the survey evidence of the motivations of the actual parties to such contracts. It seems to us that the emphasis on risk sharing, as opposed to double-sided moral hazard, found in the extant literature ignores important real-world aspects of these contractual processes. We hope this work will encourage further developments in this direction.

Appendix

■ *Proof of Theorem 1.* The program is

$$\max_{\omega(\cdot),e,r} \{E[\omega(f(e, r) + \tilde{\epsilon})] - U(r)\} \tag{A1}$$

subject to

(i) $$\frac{\partial}{\partial r}E[\omega(f(e, r) + \tilde{\epsilon})] = U'(r)$$

(ii) $$\frac{\partial}{\partial e}E[((f(e, r) + \tilde{\epsilon}) - \omega(f(e, r) + \tilde{\epsilon}))] = V'(e)$$

(iii) $$E[(f(e, r) + \tilde{\epsilon}) - \omega(f(e, r) + \tilde{\epsilon})] - V(e) \geq k.$$

Let a solution to this program be e^*, r^*, and $\omega^*(\cdot)$. Then at the optimum, we must have

$$U'(r^*) = \frac{\partial}{\partial r}E[\omega^*(f(e^*, r^*) + \tilde{\epsilon})] \tag{A2}$$

$$V'(e^*) = f_e(e^*, r^*) - \frac{\partial}{\partial e}E[\omega^*(f(e^*, r^*) + \tilde{\epsilon})]. \tag{A3}$$

Refer to the function $E[\omega^*(f(e, r) + \tilde{\epsilon})]$ as $S(f(e, r))$. Then we can rewrite the equations above as

$$U'(r^*) = S'(f(e^*, r^*))\cdot f_r(e^*, r^*) \tag{A4}$$

and

$$V'(e^*) = [1 - S'(f(e^*, r^*))]\cdot f_e(e^*, r^*). \tag{A5}$$

Consider now the alternative linear contract $F + \beta\tilde{X}$ with

$$\beta = S'(f(e^*, r^*)). \tag{A6}$$

It is easy to verify that this contract satisfies the incentive-compatibility constraints at (e^*, r^*). Furthermore, the point (e^*, r^*) is supported as a global optimum when standard Inada conditions are imposed on the relevant functions. The value of F has no impact on the incentive-compatibility constraints. Hence it can be freely adjusted to satisfy the participation constraint. *Q.E.D.*

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