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Signaling Quality with Initially Reduced Royalty Rates

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Abstract

Franchisors, such as Dunkin’ Donuts, grant reduced royalty rates to potential franchisees for the initial years of their contract period. Yet, as franchisees are initially less informed about the profitability of the franchise outlet than the franchisor, classical principal–agent theory would suggest that the franchisor should initially reduce the risk of the franchisee rather than offering more risky equity in form of initially reduced royalty rates. We suggest a solution for the puzzle of initially reduced royalty rates by pointing to the degree of complementarity between effort and outlet quality. When effort and outlet quality are complements, we show that a combination of market frictions—namely, information asymmetry and moral hazard—leads to higher incentive pay for an employed party protected by limited liability, than with only one of the two market frictions. In franchising this is reflected by contract terms which offer initially reduced royalty rates.

Keywords: Informed Principal; Moral Hazard; Signaling; Franchising; Reduced Royalty Rates

JEL Classification: D23, D82, D86.

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1 Introduction

The empirical literature has found a positive correlation between risk and incentives in compensation, sharecropping, and franchise contracts (see Prendergast, 2002 for a summary). Standard principal–agent theory, however, predicts a negative correlation. In order to rationalize this data, in his seminal paper, Prendergast (2002) proposes a modified model with effort monitoring and input–based compensation in certain environments, and delegation of responsibilities to the agent and output–based compensation in uncertain environments.1 Yet, in compensation, sharecropping, and franchise contracts, we frequently observe purely output–based compensation which is at the focus of our paper. Introducing a principal–agent model with an informed principal and an underlying moral hazard problem, we provide a rationale for the positive correlation between risk and incentives with purely output–based compensation. We apply our model to time–variant franchise contracts where uncertainty vanishes over time, which cannot be explained by the model of Prendergast (2002) or matching–based models.

In business–format franchising the franchisee receives a trade name and a complete business plan in exchange for the payment of a franchise fee and revenue–dependent royalties, as in fast–food and automotive repair franchises (Lafontaine and Shaw, 1999). Some franchisors, such as Dunkin’ Donuts, grant reduced royalty rates to potential franchisees for the initial years of their contract period. Yet, this is surprising from a theoretical point of view given that initially, franchisees tend to be less informed about the profitability of the franchise outlet than in later years. Classical principal–agent theory of hidden action would suggest that in such a setting the franchisor adjusts the contract terms initially in order to reduce the risk of the franchisee. By granting initially reduced royalty rates, however, the franchisor provides more risky equity to the franchisee since the franchisee participates more strongly in the sales revenue of the franchise outlet. Additionally, more elaborate principle–agent models which allow for combinations of market frictions—such as moral hazard and private information about the profitability of the franchise outlet on the franchisor’s side—predict an increase of royalty rates in response to a higher degree of asymmetric information, rather than a reduction of royalty rates (Gallini and Lutz, 1992; Inderst, 2001; Martimort, Poudou, and Sand-Zantman, 2010). In this paper, we suggest a solution for the puzzle of initially reduced royalty rates in an informed principal model, combined with a moral hazard problem, by pointing to the degree of complementarity between effort and outlet quality.

In recent years, various attempts have been made to determine monetary contract terms

1 Alternatively, see Ackerberg and Botticini (2002) and Legros and Newman (2007) who provide a matching–based explanation for the positive correlation between risk and incentives.
between franchisors and franchisees.\(^2\) A crucial point that received much attention in the literature has been the private information of the franchisor.\(^3\) This is due to the fact that at the beginning of a franchising relationship the franchisor can better predict the expected profitability of a specific outlet or knows better the quality of the franchise product than the franchisee. This information shortage on the franchisee’s side becomes an obstacle in providing proper incentives to the franchisee, in particular, when the franchisee’s effort choice in the franchise outlet is non–contractible, i.e., when there also exists an underlying moral hazard problem between the franchisor and the franchisee (see, for example, Chu and Sappington, 2009). In fact, the franchisor’s privileged information transforms the contracting problem into a game of incomplete information, i.e., into a signaling game. Since the franchisee finds it useful to know the profitability of the outlet, before deciding his own actions, he tries to infer the information from the franchisor’s choice of contract.\(^4,5\)

Another feature of business–format franchising is where the franchisor contracts a potential franchisee and allows him to run his own outlet, leaving the franchisee to only provide effort, which is not observable by the franchisor. Under symmetric full information about outlet quality, the first–best effort level would be implemented in such a setup if the franchisor sold the entire outlet to the franchisee, charging a franchise fee and no royalty. However, franchisees often run limited liability companies; see, for example, Dunkin’ Donuts (2012). Given the moral hazard problem, limited liability leads to a constraint in efficient contracting, generating an effort distortion even when outlet quality would be observable. Additionally, under asymmetric information, a franchisor with a high–quality outlet has to engage in costly signaling through the payment scheme in order to credibly separate from lower types.\(^6\)

In our model, an informed franchisor contracts a franchisee who is protected by limited

\(^2\) In a sample of 54 (out of 598) Disclosure Documents collected from franchisors in 1989, Bhattacharyya and Lafontaine (1995) find a fraction of 7.4% of contract terms granting initially reduced royalty rates and a fraction of 18.5% granting varying royalty rates which additionally includes sliding (i.e., decreasing) and increasing scales. These numbers are in line with the Entrepreneur’s “Franchise 500” survey which provides evidence that in that period, about 14% of franchisors indicated a variable royalty rate.

\(^3\) See, for example, Gallini and Lutz (1992) and Desai and Srinivasan (1995) on the information advance of the franchisor.

\(^4\) Often franchisors do not possess means other than monetary contract terms to convince franchisees of the high quality of their franchising outlet. In fact, due to intricacy, “the vast majority of franchisors choose not to provide revenue and profit projections to prospective franchisees. According to the IFA Educational Foundation and Frandata (2000), only 25 percent of the 1226 franchisors in their data offered an earnings claim as part of their disclosure documents”, Blair and Lafontaine (2005).

\(^5\) We shall use feminine pronouns for the franchisor and masculine ones for the franchisee.

\(^6\) In line with our model prediction that signaling the high quality of an outlet is costly to the franchisor, Kalnins and Lafontaine (2004) provide evidence that in established markets, franchisors are more likely to allocate a new franchised unit to franchisees if they already own units whose markets are contiguous and demographically similar to that of the new unit. Arguably, such franchisees face less uncertainty with respect to the profitability of the new franchised unit which reduces the need of costly signaling by the franchisor.
liability in an environment in which the output of the outlet stochastically depends on the franchisee’s non–contractible effort choice. Assuming a multiplicative effect of outlet quality and effort on expected output, i.e., that the two inputs are complements, we find that under the full observability of outlet quality, the high–quality outlet always demands a lower royalty rate and always induces a higher effort level than the low–quality outlet. This explains heterogeneous but time–invariant royalty rates or sliding (i.e., decreasing) scales for royalty rates in renewed franchise relationships when the information asymmetry no longer exists. When outlet quality is private information to the franchisor, we show that a least–cost separating equilibrium always exists and that it is unique under the intuitive criterion (Cho and Kreps, 1987). In principle, as the high–quality outlet generates a higher expected revenue than its low–quality counterpart, separation of the high–quality outlet can always be achieved through a reduction in the franchise fee alone. Given that the franchisee’s effort choice and the quality of the outlet are complements, we show, however, that the optimal (i.e., least–cost) separating signal of the high–quality franchisor includes a reduced royalty rate. In certain cases, least–cost separation is achieved through a reduced royalty rate alone. Consequently, this leads to a higher effort choice of the franchisee than under the observability of outlet quality. On the other hand, we find that the low–quality franchisor always offers the same contract terms as in the case in which outlet quality is observable. The intuition behind the reduced–royalty result is that due to the complementarity between effort and outlet quality it is less costly for the high–quality franchisor than for the low–quality one to induce a higher effort level relative to the case in which outlet quality is observable. On the contrary, separation through a reduction in the franchise fee alone would induce the same costs for both types.

This shows that in the least–cost separating equilibrium the high–quality franchisor offers more equity in the form of lower royalty rates to the franchisee than under the observability of outlet quality, whereas the low–quality franchisor does not make such an adjustment. This offers a possible explanation as to why royalty rates are found to be reduced in the initial years of franchise relationships in which the information asymmetry is still high. Our model is compatible with the two cases where a franchisor offers initially reduced royalty rates to all her franchisees, or only to specific new outlets. Offering initially reduced royalty rates to all new outlets can be understood as a commitment of the franchisor to potential franchisees that no low–quality outlets will be offered. Likewise, initially reduced royalty rates for only a frac-

7A multiplicative link between effort and sales is also mentioned by Blair and Lafontaine (2005, chap. 4.4) in order to explain the empirical finding of a positive relationship between risk and franchising.

8In the Franchise Disclosure Documents of Dunkin’Donuts (2012), for example, it is stated that initially reduced royalty rates will only be granted to new outlets.

9Note that this holds true even though, when mimicking, the low–quality franchisor would erroneously be perceived as being of high quality and would also benefit to some extent from this complementarity.
tion of outlets signals the outlet–specific market potential of these outlets, such as high local demand. In addition, we show the existence of pooling equilibria and their optimality under a weakly stronger version of the undefeated equilibrium concept by Mailath, Okuno-Fujiwara, and Postlewaite (1993) when the likelihood of low–quality outlets is sufficiently low. This result helps to explain the phenomena of uniform franchise contracts for all franchisees of a franchise chain due to the initial information asymmetry. Here, for high–quality franchisors, it does not pay off to separate themselves, as the expected quality of outlets in the market is already perceived as being very high.

The puzzle of initially reduced royalty rates cannot easily be explained by other means. One may argue that reduced royalty rates for initial years are used simply in order to transfer extra rents to new franchisees, either in order to attract them in the first place or in order to compensate them for high initial investments in certain industries. Yet, in both cases, when there is no signaling motive, principal–agent theory would clearly predict a reduction in the franchise fee to be used rather than a reduction in the royalty rate. Existing empirical evidence also suggests such a pattern (see, for example, Blair and Lafontaine, 2005). In addition, if no such rent transfer takes place, standard contract theory would suggest a reduced royalty rate to co–move with increased franchise fees. That is, initially reduced royalty rates could be off–set by a higher franchise fee. The empirical literature such as Lafontaine (1992), however, has so far predicted a positive rather than negative relationship between royalty rates and franchise fees which is well explained by our theoretical model.

Since we observe initially reduced royalty rates being granted to new outlets in developing areas, but irrespective of the franchisee’s experience, we do not expect a learning model with respect to the quality of the franchised product to explain them. The same argument applies to career concerns since only new franchisees would be affected by those.

Finally, a pure adverse selection model cannot solve the puzzle of initially reduced royalty rates. In such a setup, a high–quality franchisor has a higher expected revenue than her low–quality counterpart which renders keeping equity in the form of high royalties more profitable for the high–quality franchisor. Therefore, in a separating equilibrium, a lower upfront franchise fee and a higher royalty rate will be set by a high–quality franchisor.

The plan of our paper is as follows. In the remainder of this section, we discuss the related literature. In Section 2, we first introduce the setup and then analyze contracting under the observability of outlet quality (symmetric full information) as well as in the case where

\[10\] For an overview of the empirical results on uniform contracts, see Bhattacharyya and Lafontaine (1995). In their survey of franchise disclosure documents, Bhattacharyya and Lafontaine (1995) find a fraction of 68.6% of the contracts granting uniform royalty rates.

\[11\] For example, in 2013, Dunkin’ Donuts was offering reduced rates to old and new franchisees developing the new market of California. We will discuss this example in more detail in Section 3.3.
outlet quality is private information to the franchisor. In the latter case, least–cost separating equilibria and pooling equilibria are derived and compared with the equilibria that arise under symmetric full information, which allows us to explain the occurrence of initially reduced royalty rates. In Section 3, we discuss the robustness of our result by relinquishing limited liability and complementarity between effort and outlet quality. We also provide predictions for empirical analysis and fact–based evidence from Dunkin’ Donuts. We conclude in Section 4. Where not indicated otherwise, proofs are relegated to Appendix A. In the Web Appendix, we provide a detailed analysis of our model when the assumption of complementarity between effort and outlet quality is relaxed.

**Related Literature.** The first to observe the occurrence of initially reduced royalty rates were Bhattacharyya and Lafontaine (1995). Looking at franchise disclosure documents, they find multiple royal rates such as the policy of granting initially reduced royalty rates. Their two–sided double moral hazard model can explain the uniformity of franchise contracts, but is silent on the occurrence of initially reduced royalty rates since their model does not account for the information asymmetry and thus abstracts from signaling.12

Others such as Gallini and Lutz (1992) argue that the quality of a franchise chain could be signaled through dual distribution, i.e., the share of self–managed outlets relative to franchised ones. The authors predict that high–type franchisors show a high amount of vertically integrated outlets, since a high equity stake credibly signals high outlet profitability. Yet, there is only little empirical evidence for their prediction.13 Blair and Lafontaine (2005) point out that franchisors usually want to rapidly expand their market but are often cash constrained, which limits vertical integration as a signaling device.

Although the franchise industry provides a meaningful illustration of our setup, the scope of our analysis is more general for the theory of incentive provision. To the best of our knowledge, we are the first to show that complementarity in effort and quality leads to more effort provision. In a setting with contracting for innovation under asymmetric information, Martinort, Poudou, and Sand-Zantman (2010) mention that the complementarity between ideas (quality) and development (effort) could have such an effect, but they do not provide a formal analysis of this argument. In their paper, the authors focus on an environment in which the quality of an innovation and the effort induced by the developer are substitutes and thus do

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12 For the optimality of increasing scales for royalty rates, which are also observed by Bhattacharyya and Lafontaine (1995), a different information structure than that in our model is required: a necessity seems to be symmetric uncertainty rather than private information on the franchisor’s side. In such a case, one may predict that increasing scales, which reduce the franchisee’s incentive to exert effort but also his rent, should be more likely to be used when the uncertainty of the outlet quality is more pronounced than the moral hazard problem (i.e., when, for example, outlet quality and effort are substitutes).

13 For an exception, see Fadairo and Lanchimba (2012).
not observe a reason for initially high–powered incentives. In a similar vein, Martimort and Sand-Zantman (2006) argue that an informed government keeps a greater share of operating risk from its high–type, privately–contracted facilities when the quality of such facilities and the non–verifiable operating effort level are substitutes. Inderst (2001) analyzes a related informed principal model with an underlying moral hazard problem but, in contrast to our model, assumes that the effort level exerted by a salesperson and the profitability of a sales area are substitutes rather than complements for the expected revenue of the firm. In addition, Inderst (2001) does not allow for limited liability on the agent’s side. In such an environment, he finds that incentives for the salesperson are lower than in the case in which the profitability of a sales area is observable, which is opposed to our main result.

More generally, we differ from the classical literature of informed principal–agent relationships in the following way. Myerson (1983) analyzes a general informed–principal problem but focuses on the interrelation between different solution concepts. Therefore the characterization of equilibrium mechanisms is limited in his paper. Maskin and Tirole (1992) offer a detailed characterization of equilibrium contracts in an informed–principal problem with common values but consider problems of adverse selection only. In a mixed model of moral hazard and adverse selection, Beaudry (1994) focuses exclusively on risk–neutral agents who do not experience limited liability constraints. He emphasizes that an informed principal might benefit from transferring rents to agents in order to credibly reveal her type. Beaudry relates this finding to the appearance of efficiency wages. A solution to the moral hazard problem with an informed principal and discrete effort choice can be found in Chade and Silvers (2002), who also show that the agent may be better off, when the principal has private information than under symmetric full information. Mezzetti and Tsoulouhas (2000) enrich such a model by an information collection stage of the uninformed party—i.e., the agent—before deciding whether or not to accept the wage offer of the informed principal. In their paper, the good–type principal separates by offering an option contract which allows the agent to reject the initial offer after detecting that the principal is of bad type.

Chu and Sappington (2009) characterize the optimal contract between a principal and a risk–neutral, wealth–constrained agent when an adverse selection problem follows a moral hazard problem. Contrary to our setting, they assume that both the principal and the agent are symmetrically informed in initial periods whereas over time, the agent accumulates some private information. In their setting, the optimal contract is often more steeply sloped for the largest output levels than that in either the standard moral hazard setting or the standard adverse selection setting.

14For more recent work on informed–principal problems with common or private values, see Balkenborg and Makris (2013), Mylovanov and Tröger (2012), Mylovanov and Tröger (2013).
2 The Model

2.1 Setup

We consider two players—a risk–neutral franchisor, and a risk–neutral franchisee who is protected by limited liability. The outcome of the franchise outlet is stochastically dependent on the franchisee’s non–contractible, continuous effort choice \( e \in [0, \bar{e}] \) and on the outlet type \( i \in I = \{L, H\} \), which is private information of the franchisor. Each type of outlet refers to a technology parameter \( \theta_i \in \{\theta_L, \theta_H\} \) with \( \theta_L = 0 \) and \( \theta_H = 1 \). The franchisee’s prior beliefs about the outlet type are described by \( \beta = \text{Prob}\{i = H\} \) with \( \beta \in (0, 1) \). The outcome of both outlet types may take two realizations \( y \in [0, \bar{y}] \) with \( \bar{y} > 0 \). Franchises differ in their probability of high outcome (success probability), which is a function of the franchisee’s effort level \( e \),

\[
p_i(e) = \text{Prob}\{y = \bar{y}|\theta_i, e\} \quad \text{with} \quad e \in [0, \bar{e}] \quad \text{and} \quad 0 < p_i(\bar{e}) < 1, \forall i \in \{L, H\}. \tag{1}
\]

Furthermore, we specify \( p_i(e) \) to be represented by the following functional form,

\[
p_i(e) = p + (s_L + \Delta s\theta_i) \cdot e \tag{2}
\]

with \( p, s_L, \Delta s > 0 \). \( p \) represents the intercept and \( s_L \) and \( s_H = s_L + \Delta s \) represent the slope of the success probability function of the bad and good outlet, respectively. That is, the success probability function of both outlets has the same positive intercept and a strictly positive slope, with the slope of the good outlet being strictly higher than that of the bad outlet.\(^{17}\) Let \( c(e) = \gamma/2 \cdot e^2 \) with \( \gamma > 0 \) be the franchisee’s cost of effort function, which is strictly increasing, and strictly convex in effort. These assumptions yield a convex optimization problem in the signaling game.

By conditioning contract terms on contractible outcome, the franchisor fully describes a contract in this setting. For simplicity and without loss of generality, we assume that the franchisee is protected by limited liability of transfers at zero, i.e., we normalize the upfront franchise fee paid from franchisee to the franchisor to zero.\(^{18}\) Let \( w = (a, r) \) with \( w \in W = \mathbb{R}^2 \)

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\(^{15}\)Henceforth, we will use “outlet type” and “franchisor’s type” as synonyms.

\(^{16}\)For simplicity, we focus on a setting with binary outcomes and continuous effort choice (see also Inderst, 2001).

\(^{17}\)In the Web Appendix, we present a more general version of our model, which allows for a varying degree of complementarity between effort and the outlet type (from complements to substitutes). We discuss our findings on the more general model in Section 3.

\(^{18}\)Note that all that is required for our main results to hold is that the limited liability constraint is binding under full observability of outlet quality.
state a contract that the franchisor offers to the franchisee. The franchisee pays the franchise fee and possibly receives a reduction in the franchise fee \( a \geq 0 \) at the beginning of the contract period, and pays a royalty rate \( r \) on his sales to the franchisor, thus keeping \( a + y(1 - r) \) with \( y \in \{0, \bar{y}\} \).

The franchisee can either accept the franchisor’s offer and exert a non-negative effort level, \( e \), or reject the offer. For given output realization \( y \), wage payment \( w(y) = a + y(1 - r) \), and effort level \( e \), the franchisor receives a utility of \( v(w(y), y) = y - w(y) \) and the franchisee a utility of \( u(w(y), e) = w(y) - c(e) \). Outside options are zero.

For any accepted term offer \( w = (a, r) \), the franchisee maximizes his expected contract payment minus his costs of effort over \( e \). The franchisee’s effort choice is dependent on his conditional belief \( \mu(i|w) \) about the outlet type \( i \), where \( \mu \) maps \( W \) into the simplex \( \Delta_2 \). Given our assumptions, which imply concavity of \( p_i(e) \) and the strict convexity of \( c(e) \), there exists a unique solution to the franchisee’s problem. For a given term offer \( w \) and corresponding beliefs \( \mu(i|w) \), the first-order necessary condition of the franchisee’s problem equals

\[
\sum_{i \in \{L, H\}} \mu(i|w)p_i'(e) \cdot \bar{y}(1 - r) - c'(e) = 0. \tag{3}
\]

We denote the solution to the franchisee’s problem by \( \hat{e} = e(r, \mu(i|w)) \). Note that given that the franchisee’s participation constraint is satisfied, his effort choice is only indirectly affected by the reduction in the franchise fee \( f \) through his beliefs about the outlet type \( i \). Next, we incorporate the underlying moral hazard problem by defining the following indirect utility functions:

- Franchisor:

\[
V_i(r, \mu(i|w)) = p_i(\hat{e}) \cdot \bar{y}r - a,
\]

- Franchisee:

\[
U_i(r, \mu(i|w)) = p_i(\hat{e}) \cdot \bar{y}(1 - r) + a - c(\hat{e}),
\]

where \( i \in \{L, H\} \) and \( \mu(i|w) \in [0, 1] \).

\[\footnote{In line with other informed principal models with moral hazard (mixed models) such as Beaudry (1994) and Martimort, Poudou, and Sand-Zantman (2010) but contrary to Maskin and Tirole (1992)’s pure informed principal model, we do not allow the franchisor to offer a menu of contracts from which she chooses after the franchisee has accepted the offer. The main reason why we focus on single contracts is that those are more realistic given the underlying moral hazard problem and also simplify our analysis. In addition, our assumption of limited liability hinders a direct comparison to the setup of Maskin and Tirole (1992).} \]
Henceforth, we abbreviate $V_i(w, 1)$ by $V_{ii}(w)$ and $V_i(w, 0)$ by $V_{ij}(w)$ for all $i, j \in \{L, H\}, i \neq j$. We proceed analogously for the franchisee’s utility, i.e., $U_{ii}(w) \equiv U_i(w, 1)$ and $U_{ij}(w) \equiv U_i(w, 0)$.

Given the structure on $p_i(e)$ and $c(e)$, we obtain strict concavity of $V$ and $U$ in $-r$ and $e$, respectively.

The timing and the information structure of the game is as follows. At date zero the franchisor learns the outlet type and makes a take–it–or–leave–it contract offer to the franchisee. The franchisee updates his beliefs about the outlet type conditional on the offered contract term and then decides whether or not to accept the contract. If the franchisee accepts the offer, he chooses the optimal effort level given his beliefs. Then the outcome is realized and the franchisor makes the scheduled term payment to the franchisee. If the franchisee rejects the offer, both players receive their outside option of zero. As a solution concept, we use the Perfect Bayesian Nash Equilibrium (PBE). Denote the franchisor’s strategy by $\sigma_P$, where for each $i$, $\sigma_P(.|i)$ is a probability distribution over $W$ and the franchisee’s strategy by $\sigma_A$, where for each $w$, $\sigma_A(.|w)$ is a probability distribution over the set $\{0, 1\}$. Here, 1 represents acceptance by the franchisee, while 0 represents rejection. Thus, an equilibrium is determined by a vector of strategies and beliefs $\sigma = (\sigma_P, \sigma_A, \mu)$.

2.2 Observable Outlet Type

We begin with symmetric full information which we define as our benchmark case. We show that even if the franchisee observes the outlet type, the fact that the franchisee is protected by limited liability results in a downward distortion of the franchisee’s effort choice. Furthermore, the franchisee receives a positive rent. We also show that for a high–quality outlet, the royalty rate is always lower and the induced effort level is always higher than for a low–quality outlet.

If outlet type $i$ is observable (symmetric full information), then the setting reduces to a pure moral hazard problem. The first–best effort level of outlet $i$, $e_{FBi}$, is determined by

$$p_i'(e)\tilde{y} = c_i'(e) \quad \forall i \in \{L, H\}. \quad (4)$$

We receive that $e_{FBi}$ is equal to $(s_L + \Delta s \theta_i)\tilde{y}/\gamma$. Since the franchisee is protected by limited liability at zero transfer, the moral hazard problem generates a downward distortion in effort.\footnote{Suppose the contrary, then given risk neutrality of both players, the franchisee’s effort choice must be first–best efficient, which corresponds to selling the entire outlet to the franchisee. At this, the franchisor optimally chooses the franchise fee $a = -(p_i(e_{FBi})\tilde{y} - c(e_{FBi}))$ in order to leave the franchisee without rent. But since $a$ is strictly negative for franchises with positive net present value, the limited liability constraint will be binding and a distortion arises.}

Applying the implicit function theorem (IFT) to the franchisee’s first–order necessary condi-
We find that for given beliefs, the relationship between effort level $e$ and royalty rate $r_i$ is negative

$$\frac{d\hat{e}}{dr_i} = -\frac{(s_L + \Delta s\theta_i)\bar{y}}{\gamma} < 0 \quad \forall i.$$ (5)

We therefore conclude that for the given beliefs of the franchisee, a decrease in the royalty rate leads to a higher effort level. Yet, it also follows from (5) that if the outlet is perceived as being of high quality by the franchisee, an incremental effort level can be implemented by a smaller reduction in the royalty rate, i.e., is less costly to induce for the franchisor. This creates incentives for a low–type franchisor to mimic a good outlet, as will be examined in the Section 2.3. We next consider the franchisor’s problem. For outlet type $i$, the franchisor’s problem equals

$$\max_{(a_i, r_i)} \left\{ p_i(\hat{e}) \cdot \bar{y}r_i - a_i \right\}$$ (6)

s.t.

$$f_i \geq 0$$ \quad (LL_i)

$$U_i(a_i, r_i) \geq 0$$ \quad (IR_i)

$$\hat{e} = \arg \max_{e} p_i(e) \cdot \bar{y}(1 - r_i) + a_i - c(e).$$ \quad (IC_i)

We make the following assumption on the parameters of $p_i(e)$ and $c(e)$ in order to yield positive solutions of $\hat{e}$.

**Assumption 1.**

$$\gamma p < \bar{y}s_L^2.$$ \quad

Intuitively, in order to yield $\hat{e} > 0$, the moral hazard problem should not be too severe. This means that the costs of exerting effort, $\gamma$, and the intercept of the success probability function, $p$, should not be too large relative to the outcome under success, $\bar{y}$, and the slope of the success probability function of at least the low–quality outlet, $s_L$.

The next lemma characterizes the optimal payment scheme and induced effort level of the franchisor’s problem in (6).

**Lemma 1.** Suppose outlet type $i$, with $i \in \{L, H\}$ is observable. Then, the franchisor offers the contract $w_i^* = (a_i^*, r_i^*)$ which implies an effort level $e_i^*$ with $a_i^* = 0$, $r_i^* = 1/2 + \gamma p/(2(s_L + \Delta s\theta_i)^2\bar{y})$, and $e_i^* = (s_L + \Delta s\theta_i)\bar{y}/(2\gamma) - p/(2(s_L + \Delta s\theta_i))$.

This lemma indicates that royalty rates are decreasing in outlet quality, i.e., $r_H^* < r_L^*$. 


whereas the induced effort levels are increasing in outlet quality such that $e^*_H > e^*_L$. Note that $(IR_i)$ is satisfied with strict inequality at $e^*_i$, i.e., the franchisee receives a positive rent.

In our setup, such contract terms would be offered to an experienced franchisee who has his contract renewed or to an internal manager (vertical integration) who is able to observe whether the outlet is of high or low quality.

2.3 Unobservable Outlet Type

2.3.1 Separating Equilibria

Suppose now that the outlet type is private information to the franchisor. If a franchisor with a good outlet offers the second–best contract from the previous section, she might be mimicked by a franchisor with the bad outlet. The reason for this is that being perceived as the good–type franchisor increases a franchisee’s effort level per royalty rate. By the same argument, mimicking in the opposed direction is not profitable. In certain settings when good–type outlets are very likely, however, it might be extremely costly for a good–type franchisor to separate from her low–type counterpart. This raises the issue of the optimality of pooling equilibria which we address in Section 2.3.2.

In the following, we consider PBE in pure strategies and focus on the least–cost separating contract. The refinement we choose is the intuitive criterion of Cho and Kreps (1987). Note that in our setup a franchisor with the good outlet ($H$–type franchisor) can adjust her royalty rate $r_H$ as well as her franchise fee $a_H$ in order to separate from a $L$–type franchisor. To solve the least–cost separating equilibrium $(w^*_L, w^*_H) = ((a^*_L, r^*_L), (a^*_H, r^*_H))$, we first show in Lemma 2 that in any separating equilibrium the $L$–type franchisor will offer the second–best contract from the previous section, i.e. $w^*_L = w^*_L = (0, r^*_L)$. In Lemma 3, we then derive the unique least–cost separating contract $w^*_H$ for the $H$–type franchisor which satisfies the incentive constraint of the $L$–type franchisor given that $w^*_L = w^*_L$. In Lemma 4, it is shown that under our assumptions, the least–cost separating contract is always more profitable for an $H$–type franchisor than the best non-separation contract $(0, r^*_HL)$. Note that this step is non–redundant due to the potential violation of the Spence–Mirrlees condition in our setup. In Proposition 1, we state existence of the least–cost separating equilibrium $(w^*_L, w^*_H)$ and uniqueness under the intuitive criterion. The properties of the the least–cost separating equilibrium presented in Lemma 3, and the subgame perfect Nash equilibrium under symmetric full information presented in Lemma 1, are compared in Proposition 2. This delivers our main result, namely that offered royalty rates are lower when information asymmetries exist.

First, we determine $w^*_L$. If $w^*_H$ is such that mimicking the $H$–type is not profitable for the $L$–type franchisor, the $L$ type’s incentive constraint must be satisfied and potentially binding. The
next lemma shows that in such a case, the $L$–type franchisor will always offer the second–best contract from above, $w_L^* = (0, r_L^*)$.

**Lemma 2.** Suppose that outlet type $i$ is unobservable and that the incentive constraint for the $L$–type franchisor, $(IC_{F_L})$, is satisfied. Then, $w_L^* = (0, r_L^*)$.

The least–cost separating contract for the $H$–type franchisor, $w_H^*$, can be derived from the $H$–type franchisor’s problem given that the incentive constraint for the $L$–type franchisor, $(IC_{F_L})$ is satisfied,

$$\max_{(w_H^*, e_H)} p_H(\hat{e}) \cdot \bar{y}r_H^* - a_H^*$$

s.t.

$$a_H^* \geq 0 \quad (LL_H)$$

$$U_{HH}(w_H^*) \geq 0 \quad (IR_H)$$

$$\hat{e} = \arg \max_{e} p_H(e) \cdot \bar{y}(1 - r_H^*) + a_H^* - c(e) \quad (IC_H)$$

$$V_{LL}(w_H^*) \leq V_{LL}(w_L^*). \quad (IC_{F_L})$$

In Lemma 3, the unique least–cost separating contract for the $H$–type franchisor’s problem is derived.

**Lemma 3** (Least–Cost Separation). Suppose outlet type $i$ is unobservable. Then, there exists a unique least–cost separating contract $(w_L^*, w_H^*) = ((0, r_L^*), (a_H^*, r_H^*))$ for both types of franchisors. Define $\gamma_L^1 \equiv \sqrt{\frac{s_L^3}{\gamma^2}}$ and $\gamma_L^2 \equiv \sqrt{\frac{s_L^3}{\Delta s(s_L + \Delta s)^3}}$, with $\gamma_L^1 \leq \gamma_L^2$. The reduction in franchise fee $a_H^*$, the royalty rate $r_H^*$, and the effort level $e_H^*$ induced by $(w_L^*, w_H^*)$ are characterized as follows

1. **(interior solution)** if and only if $(IC_H)$ and $(IC_{F_L})$ are binding, and $(LL_H)$ and $(IR_H)$ are not binding, which is equivalent to $\gamma p < \gamma^1_L$,

$$a_H^* = \frac{\gamma_L^2 \Delta s^2 - \gamma^2_L p^2}{4\gamma^3_L},$$

$$r_H^* = \frac{1}{2},$$

$$e_H^* = \frac{s_L + \Delta s}{2\gamma}.$$  

2. **(corner solution)** if and only if $(LL_H)$, $(IC_H)$, and $(IC_{F_L})$ are binding, and $(IR_H)$ is not binding, which is equivalent to $\gamma p < \gamma^2_L$,

$$a_H^* = 0,$$

$$r_H^* = \frac{1}{2} + \frac{\gamma p}{2s_L(s_L + \Delta s)\gamma^2} - \frac{\sqrt{s_L \Delta s(r_H^*(s_L + \Delta s))^2 - \gamma^2_L p^2}}{2\gamma^3_L(s_L + \Delta s)^2},$$

$$e_H^* = \frac{s_L + \Delta s}{2\gamma} - \frac{p}{2s_L} + \frac{\sqrt{s_L \Delta s(r_H^*(s_L + \Delta s))^2 - \gamma^2_L p^2}}{2\gamma^3_L},$$
3. (trivial solution) if and only if (ICF) is trivially satisfied, which is equivalent to \( \gamma_2 \leq \gamma p \),

\[
\begin{align*}
    a^*_H &= a^*_L = 0, \\
    r^*_H &= r^*_L = \frac{1}{2} + \frac{\gamma p}{2(s_L + \Delta s)^2}, \\
    e^*_H &= e^*_L = \frac{1}{2} - \frac{\gamma p}{2(s_L + \Delta s)^2}.
\end{align*}
\]

In interior solutions, the \( H \)-type franchisor credibly signals her type by a combination of a reduction in the franchise fee (with \( a^*_H > 0 \)) and a reduced royalty rate (\( r^*_H < r^*_L \)) relative to the case in which outlet quality is observable. Given our specification of \( p_i(e) \) and \( c(e) \), solutions in Lemma 3 are interior if and only if \( \gamma p < \gamma_1^* = \bar{y} \sqrt{s_L^2 \Delta s} \). Intuitively, this means that the moral hazard problem is not too severe: the cost of exerting effort, \( \gamma \), and the intercept of the success probability function, \( p \), have to be sufficiently low relative to the outcome under success, \( \bar{y} \), and the slope of the success probability functions, \( s_L \) and \( s_L + \Delta s \). A corner solution occurs if and only if \( \gamma_1^* \leq \gamma p < \gamma_2^* \), which reflects an intermediate level of severity of the moral hazard problem. In this case, separation of the \( H \)-type franchisor is achieved solely through a reduced royalty rate. This is due to the fact that inducing a higher effort level than \( e^*_H \) is excessively more costly for the \( L \)-type franchisor here. In fact in this case, the optimal effort level of the \( L \)-type and \( H \)-type franchisor when quality was observable differs a lot, which then facilitates separation. For \( \gamma p \geq \gamma_2^* \), the moral hazard becomes so severe that a trivial solution arises. Here, the high type does not need to separate, since the low type will never find it profitable to mimic her. Overall, the \( H \)-type’s royalty rate is the lowest in an interior solution and the highest in a trivial solution and vice versa for the induced effort levels (see Proposition 2 for more details).

We next verify that the least–cost separating contract, \( w^*_H \), is preferable for the \( H \)-type franchisor relative to her best non–separating contract \((0, r^*_{HL})\). This is important since the Spence–Mirrlees condition might not be globally satisfied in our setup, and therefore the \( H \)-type franchisor could have an incentive to deviate from the least–cost separating contract \( w^*_H \). Her best deviation under pessimistic beliefs by the franchisee, \( \mu(H|w \neq w^*_H) = 0 \), is given by \((0, r^*_{HL})\), where \( r^*_{HL} \) is her optimal royalty rate when being perceived as a low type, i.e., \( r^*_{HL} = \arg \max_r V_{HL}(0, r) \). We find that \( r^*_{HL} = 1/2 + \gamma p/(2s_L(s_L + \Delta s)\bar{y}) \) and \( e^*_{HL} = s_L\bar{y}/(2\gamma) - p/(2(s_L + \Delta s)) \). In the interior solution case, the necessary and sufficient condition for optimality of least–cost separation, \( V_{HH}(w^*_H) \geq V_{HL}(0, r^*_{HL}) \), becomes equivalent to

\[
\frac{\Delta s^2 \bar{y}^2}{\gamma} + \frac{\Delta s \gamma p^2}{s_L^2(s_L + \Delta s)} \geq 0,
\]

whose LHS is strictly positive. Therefore, least–cost separation is always optimal in the interior solution case. A similar argument can be made for corner solutions (see the proof of the next lemma). The next lemma summarizes these findings.
Lemma 4 (Optimality of Least–Cost Separation). Suppose outlet type i is unobservable and the franchisee holds pessimistic beliefs besides the least–cost separating contract, $\mu(H|w \neq w^*_H) = 0$. The H–type franchisor always prefers the least–cost separating contract, $w^*_H$, to the optimal non–separating contract, $(0, r^*_HL)$, i.e. $V_{HH}(w^*_H) > V_{HL}((0, r^*_HL))$.

In the following we will focus on parameters which yield interior or corner solutions. In the next proposition, it is shown that the least–cost separating contract can indeed be implemented as PBE and that it is unique under the intuitive criterion.

Proposition 1. Suppose outlet type i is unobservable. Then, there exists an equilibrium $\sigma = (\sigma_P, \sigma_A, \mu)$ that implements the least–cost separating contract, i.e. $\sigma_P(w^*_L|L) = 1, \sigma_P(w^*_H|H) = 1, \sigma_A(1|w^*_L) = 1, \sigma_A(1|w^*_H) = 1$, and $\mu(H|w^*_H) = 1$. Moreover, any equilibrium that satisfies the intuitive criterion implements the least–cost separating contract.

The next proposition compares the equilibrium properties of the game with private information and that of symmetric full information. It states our explanation for the puzzle of initially reduced royalty rates.

Proposition 2. Suppose $p_i(e)$ and $c(e)$ are such that the incentive constraint of the L–type franchisor is not trivially satisfied by $w^*_L$ (i.e., $\gamma_P < \gamma_2^L$). Then, the royalty rate, $r^*_H$, in the least–cost separating contract $w^*_H$ under asymmetric information is lower than the royalty rate, $r^*_H$, under symmetric full information, i.e., $r^*_H < r^*_H$.

This result states our main argument: a franchisor who wants to convince a future franchisee of the high quality of her franchise outlet requires a lower royalty rate for the initial years in which the franchisee’s uncertainty about the outlet quality is high. Given that outlet quality and effort are complements, this is a credible signal of being of high quality and, in combination with the lower royalty rate, increases the efficiency of the franchisee’s effort choice. After the information problem has leveled, the franchisor no longer induces costly over–investment in effort by the franchisee. Note that Proposition 2 holds more generally as will be discussed in Section 3 and is shown in the proof of Proposition 5 in the Web Appendix.

2.3.2 Pooling Equilibria

A disadvantage of the intuitive criterion applied in Proposition 1 is that its selection is not sensitive to the prior distribution of types. This is particularly worrisome if the probability of $H$–type outlets $\beta$ is close to one, and therefore also the expected success probability at the ex ante stage is close to that of $H$–type outlets. In this situation, the $H$–type franchisor may benefit from offering a pooling contract since, for $\beta \rightarrow 1$, her optimal pooling contract approaches her second–best contract under observable outlet type, which is strictly more profitable than
any nontrivial least–cost separating contract. This holds true since nontrivial separation adds another binding constraint to the \( H \)--type franchisor’s problem.

In order to allow for the equilibrium selection of pooling equilibria of this kind, we depart from the intuitive criterion in the following. A different selection procedure—namely, lexicographical maximum selection—is introduced. This concept is introduced by Inderst (2001) and initiates a weakly stronger selection than the undefeated equilibrium concept by Mailath, Okuno-Fujiwara, and Postlewaite (1993).\textsuperscript{22} The set of lexicographical maximum equilibria is defined by \( M^* \equiv M_L(M_H(\Sigma)) \) with \( \Sigma \) being a compact subset of the set of PBE and \( M_i(\Sigma) \) the set of equilibria maximizing the payoff of type \( i \).

Next, we derive the allocation of the \( H \) type’s optimal pooling equilibrium as a function of beliefs \( \beta \).\textsuperscript{23} Then, we state the set of lexicographical maximum equilibria and the motion of implied royalty rates as a function of beliefs \( \beta \) in Proposition 3 and 4.

For given beliefs \( \beta \in [0,1] \), let \( r^P(\beta) \) denote the royalty rate in the \( H \) type’s optimal pooling equilibrium. Then, for given \( r^P(\beta) \) and beliefs \( \beta \in [0,1] \), the franchisee’s problem is characterized by

\[
\left( \beta p'_H(e) + (1 - \beta)p'_L(e) \right)\bar{y}(1 - r^P(\beta)) = c'(e),
\]

compare (3).

Applying (9) and solving the \( H \)--type franchisor’s problem analogously to Lemma 1, the optimal pooling royalty rate for the \( H \)--type franchisor, \( r^P(\beta) \), satisfies \( r^P(\beta) \in [r^*_{HL}, r^*_{HL}] \) with \( r^P(0) = r^*_{HL} \) and \( r^P(1) = r^*_{HL} \). It is given by

\[
r^P(\beta) = \frac{1}{2} + \frac{\gamma p}{2(s_L + \Delta s)(s_L + \beta \cdot \Delta s)\bar{y}}.
\]

The corresponding effort level is equal to \( e^P(\beta) = (s_L + \beta \cdot \Delta s)\bar{y}/(2\gamma) - p/(2(s_L + \Delta s)) \), where \( e^P(\beta) \in [e^*_{HL}, e^*_{HL}] \) as \( e^P(0) = e^*_{HL} \) and \( e^P(1) = e^*_{HL} \).

The next proposition shows that for given beliefs \( \beta \), all equilibria in \( M^* \) implement a unique allocation. There exists a cutoff level \( \beta^* \in (0,1) \) such that all equilibria in \( M^* \) implement the least–cost separating allocation for \( \beta < \beta^* \), while for \( \beta \geq \beta^* \) all equilibria in \( M^* \) implement the unique optimal pooling allocation for the \( H \)--type franchisor.

**Proposition 3.** Suppose that outlet type \( i \) is unobservable and that the incentive constraint of the \( L \)--type franchisor is not trivially satisfied by \( w^*_H \). Then, there exists a unique value

\[\text{\textsuperscript{22}}\text{In contrast to Mailath’s undefeated equilibrium concept, the lexicographical maximum equilibrium concept selects a unique equilibrium in our game.}\]

\[\text{\textsuperscript{23}}\text{We show in the proof of Proposition 3 that for the \( L \)--type franchisor, this allocation is also preferable to that under separation whenever the same holds true for the \( H \)--type franchisor.}\]
\( \beta^c \in (0, 1) \) such that for \( \beta < \beta^c \) all equilibria \( \sigma \in M^* \) specify the least–cost separating contract \((w_L^*, w_H^*)\), while for \( \beta \geq \beta^c \) they specify the optimal pooling contract of the high–type franchisor \( w^p(\beta) = (0, r^p(\beta)) \) with \( r^p(\beta) \) given by (10).

The next proposition describes the motion of the royalty rate, induced by the \( H \)–type franchisor in the lexicographical maximum equilibrium, as a function of the prior probability of facing an \( H \)–type franchisor \( \beta \).

**Proposition 4.** Consider the lexicographical maximum equilibrium from above. For \( \beta < \beta^c \) the royalty rate induced through the \( H \)–type franchisor is constant at a level of \( r^s_H \), while, at \( \beta = \beta^c \), there is a discontinuity in \( r^s_H \). More precisely, \( r^s_H \) jumps upward to \( r^p(\beta^c) \) and for \( \beta > \beta^c \) is strictly decreasing down to \( r^p(1) = r^*_H > r^s_H \).

Analogously, the royalty rate induced by the \( L \)–type franchisor is constant at \( r^*_L \) for \( \beta < \beta^c \) and for \( \beta \geq \beta^c \) is identical to the royalty rate induced by the \( H \)–type franchisor. If \( \beta \geq \beta^c \), then the induced royalty rate is always weakly higher than the second–best royalty rate of the \( H \)–type franchisor.

This result helps to explain the phenomena of uniform franchise contracts even if there exists an initial information asymmetry. Intuitively, it does not pay off for high–quality franchisors to separate themselves when the expected quality of outlets in the market is very high.

### 3 Discussion

#### 3.1 Robustness Analysis

In this section, we examine the robustness of our main result by relinquishing complementarity between effort and outlet quality as well as limited liability. In the previous section, we have focused on a setup in which effort and outlet type have a multiplicative effect on expected outcome. In the Web Appendix, we present a more general version of our model which allows for a varying degree of complementarity between effort and the outlet type, by including a multiplicative term (complements) as well as an additive one (substitutes), i.e., \( \tilde{p}_i(e) = (p + \Delta p \theta_i) + (s_L + \Delta s \theta_i) \cdot e \), with \( \Delta p \geq 0 \). We find support for our result of reduced royalty rates if and only if the complementarity between effort and outlet type is sufficiently strong, i.e., the difference in slopes \( \Delta s \) is sufficiently larger than the difference in intercepts \( \Delta p \). Otherwise, the information asymmetry could well lead to an increase in royalty rates as found, for example, by Inderst (2001) who considers a purely additive relationship. Note also that our functional form assumptions on \( \tilde{p}_i(e) \) and \( c(e) \) nor our assumption that \( \tilde{p}_i(e) \) is an affine function of \( \theta_i \), are necessary in order to prove Proposition 5. That proposition determines the critical degree
of complementarity for reduced vs. increasing royalty rates in the more general model. In fact, concavity of \( \tilde{p}_i(e) \) and convexity of the cost of effort function \( c(e) \) together with \( \tilde{p}'_H(e) > \tilde{p}'_L(e) > 0 \) are sufficient. But as proving existence without functional forms is very difficult in our setup (see Lemma 6), we refrain from presenting a model without functional forms in the Web Appendix.

Our reduced royalty rate result also relies on the assumption that contracting under symmetric full information is already second best with respect to the franchisee’s effort choice, i.e., that the moral hazard problem between the franchisor and the franchisee already generates a distortion of the effort choice by itself. In general, such a distortion could be caused by limited liability or risk aversion on the franchisee’s side. We next show that in our setup, the reduced royalty rate result would vanish if the limited liability constraint was fully relaxed. We therefore introduce the modified limited liability condition,

\[
a \geq -l \quad \text{with} \quad -l = a^{FB}_H = \frac{\bar{y}(s_L + \Delta s)^2 + 2\gamma p}{2\gamma} < 0.
\]

The next lemma states the induced effort levels under the modified limited liability condition.

**Lemma 5.** Suppose (LL’) holds. Then, the effort level induced by the H type’s least–cost separating contract is the same as under (LL), whereas the effort level when outlet quality is observable increases to the first–best level, \( e^{FB}_H \) with \( e^{FB}_H = \frac{(s_L + \Delta s)\bar{y}}{\gamma} \).

This directly implies that for \( l \) sufficiently large, the effort level when outlet quality is observable is higher than when outlet quality is private information to the franchisor. Correspondingly, the royalty rate is lower in the former case than in the latter one, which contradicts the reduced royalty rate result. On the other hand, we are confident that our result of reduced royalty rates carries over to models in which the agent is risk averse rather than risk neutral and of limited liability.

Finally, we want to point out that our results convey the same qualitative message as in a periodical model, where the information asymmetry vanishes over time.

### 3.2 Predictions

In this section, we discuss the predictions which can be drawn from the dynamic interpretation of our static model (asymmetric information at the contracting stage vs. symmetric full information at the contract renewal stage). We focus on the case in which, under symmetric full information, only high–quality outlets are profitable. In this case, we predict initially reduced royalty rates to be offered for all new outlets of a franchisor at a certain moment in time only if the uncertainty experienced by potential franchisees’ is sufficiently high, i.e., the expected
quality of outlets in the market is sufficiently low (cf. \( \beta < \beta^* \), in Proposition 3). Here, offering initially reduced royalty rates can be understood as credible commitment of the franchisor not to open low–quality outlets which would become profitable when being misperceived as high–quality ones by the franchisees. This possibly describes best a situation, where a franchisor quickly enters a large, new market such that new franchisees cannot draw inferences from existing outlets in the neighborhood.\(^{24}\) We further predict that the reduction in the royalty rate is largest and combined with a reduction in the franchise fee, when the complementarity between effort and outlet quality is large (cf. \( \Delta s \) and \( \gamma^c_1 \) being large relative to \( \gamma p \), interior solution in Lemma 3). Here, mimicking is very attractive. For a decreasing degree of complementarity, we first expect the reduction in the franchise fee to monotonically decrease to zero and then the reduction in the royalty rate (cf. corner and trivial solution in Lemma 3).

Another and probably more important reason for why in our model, franchisors should not always offer initially reduced royalty rates is the invariance of signaling costs to the expected quality of outlets in the market. If the expected quality of outlets in the market is sufficiently high, it becomes optimal for the franchisor to offer uniform, time–invariant royalty rates to all new franchisees, consequently allowing for low–quality outlets to be opened (cf. \( \beta \geq \beta^* \), in Proposition 3). This most likely fits to franchise contracts being offered in a well–developed market.

Furthermore, our model can explain why franchisors grant sliding (i.e. decreasing) scales to their franchisees as observed by Bhattacharyya and Lafontaine (1995). At the contract renewal stage, the franchisee is symmetrically informed about the outlet and receives a lower royalty rate in a high–quality outlet compared to a low-quality one (cf. Lemma 1).

### 3.3 Empirical Relevance

The empirical relevance of our results can easily be shown by the example of Dunkin’ Donuts. Dunkin’ Donuts is operating in many U.S. states and announced in a press release in December 2012 to first expand into the market of southern California and later into the whole of California, where they had not been present before.\(^{25}\) In order to attain franchisees, they offered initially reduced royalty rates for all those franchisees opening up an outlet in this developing area.\(^{26}\) In Dunkin’ Donuts’ Franchise Disclosure Documents, it is stated that in general, Dunkin’ Donuts is asking its franchisees for a royalty rate of 5.9% on annual sales with annual

\(^{24}\)Cf. the example of Dunkin’ Donuts entering the market of California in 2013 discussed in the next section.


\(^{26}\)On our own inquiry, Dunkin’ Donuts confirmed that the reduced rate is granted to all franchisees, irrespective of their franchise experience.
sales amounting to approximately 800’000$ a year. In addition, in developing areas, franchisees receive an initially reduced royalty rate of 3.9% for the first two years and 4.9% for the third year. Note that if initially reduced royalty rates were only granted because sales for the first years are lower than for later years, initially reduced royalty rates ought to be granted for all new outlets around the country and not only for those opening up in developing markets.

The upfront franchise fee that has to be paid is usually between $40,000 and $80,000 and can vary across the United States depending on brand presence. Therefore, as predicted by standard principal–agent theory, the initial rent transfer could have also been achieved by a reduction in the franchise fee rather than the royalty rate. Yet, we do not observe such an outcome which is in line with our model predictions.

In general, Dunkin’ Donuts offers to open outlets throughout the U.S., for which they are looking for franchisees.27 Usually, it is Dunkin’ Donuts who determines where to open up a new outlet which supports our assumption of an informed franchisor.

Given the fact that only stores in the developing areas receive initially reduced rates rather than stores that open up in already developed areas in the U.S., we expect the higher uncertainty in the developing areas to be a key driver of those franchise agreements. If it was a pure, nation–wide growth campaign, Dunkin’ Donuts should offer initially reduced royalty rates to all new outlets in the U.S. irrespective of Dunkin’ Donuts’ presence in a specific area.

As Dunkin’ Donuts expects its chain to become more established in California, it signals profitability by granting reduced royalty rates in the initial period, but demands higher royalty rates later on.29

4 Conclusion

In this paper, we consider an one–shot moral hazard problem between a risk–neutral franchisor and a risk–neutral franchisee who is protected by limited liability, combined with an information asymmetry, where the franchisor is privately informed. By comparing asymmetric information and symmetric full information, we are able to predict time–variant contract terms in settings where asymmetric information vanishes over time. In our model, information is output relevant and thus of common value. We analyze the resulting signaling game when asymmetric information is present by deriving the least–cost separating equilibrium, in which the high–type franchisor separates herself via the payment scheme from her low–type counterpart. To the best of our knowledge, our paper is the first to highlight the relevance of the

28The franchisee can at most propose a location for an outlet, which might then be taken into consideration by Dunkin’ Donuts.
29Such a dynamic of royalty rates is also found by Preißner (2005).
degree of complementarities between effort and outlet type, in determining whether incentive pay increases or decreases in such a context relative to a pure moral hazard problem without information asymmetry. In contrast to the existing literature on principal–agent theory, we show that when the degree of complementarities between effort and outlet type is high, the high–type franchisor signals the quality of her franchise outlet with initially reduced royalty rates. This implies that the effort level exerted by the franchisee in the least–cost separating contract is higher than in the high–quality contract when quality is observable, i.e., the third–best effort level is higher than the second–best one.30

The intuition behind this result is that the franchisor with favorable information wants to recoup efficiency in effort relative to the setting with symmetric full information, in order to prevent the franchisor with unfavorable information from mimicking. This is possible when effort and output–relevant information are complements since implementing higher effort is more costly for the franchisor with unfavorable information.

Furthermore, the franchising literature has long questioned why contracts of the same franchisor are often uniform for different franchisees. Our result that pooling contracts can be optimal suggests that asymmetric information might be an additional explanation for contractual uniformity.

Other ways of signaling quality, such as the vertical integration of a certain fraction of outlets or signaling through non–monetary contract terms, lie beyond the scope of our model. Yet, we also believe that those alternative explanations are of minor importance, as franchisors are often equity constrained, and hard information is difficult to transmit in the franchise industry.

Finally and more generally, our model provides a novel rationale for the positive correlation between risk and incentives in compensation, sharecropping, and franchise contracts observed by the empirical literature (see Prendergast, 2002 for an overview). When the risk of the agent increases together with the private information of the principal—as it might be the case in market environments which are completely new and unpredictable to the agent but less so to the principal—we predict an upcoming signaling motive of the principal to give rise to more high–powered incentives (under a sufficiently high degree of complementarity between effort and principal type).

30In our setup, the first–best effort level is never reached due to limited liability on the franchisee’s side.
Appendix

A Relegated Proofs

Proof of Lemma 1. We first show that for interior solutions, the franchisee’s individual rationality constraint (\(IR_i\)) is not binding and that the limited liability constraint (\(LL_i\)) is binding instead. Suppose by contradiction (\(IR_i\)) is binding. Then, solving (\(IR_i\)) for \(a_i\) and substituting \(f_i\) in the franchisor’s objective function by \(a_i = c(\hat{e}) - p_i(\hat{e})\bar{y}(1 - r_i)\) yields \(p_i(\hat{e})\bar{y} - c(\hat{e})\) as a modified objective function. The modified objective function is maximized at the first–best effort level. As mentioned in the main text, \(a_i\) will be negative at \(e_i^F\) which violates (\(LL_i\)). Thus, (\(IR_i\)) cannot be binding. If \(a_i\) is positive, however, decreasing \(a_i\) to zero is beneficial for the franchisor by additive separability of \(V\) in \(f\) and keeps (\(LL_i\)) satisfied. Thus, (\(LL_i\)) is binding, i.e., \(a_i = 0\), while (\(IR_i\)) is not binding. In addition, it is easy to verify that the first–order approach is valid in our setup. We therefore can replace (\(IC_i\)) by the first–order condition of the franchisee’s problem.

Next, using that \(a_i = 0\) and that \(\hat{e} = e_i(r) = (1 - r)(s_L + \Delta s\theta)\bar{y}/\gamma\) by solving (\(IC_i\)), the franchisor’s objective function can be expressed by \(p_i(e_i(r))\bar{y}r\). Taking the first derivative w.r.t. \(r\) yields \(r_i^* = 1/2 + \gamma p/2(s_L + \Delta s\theta)^2\bar{y}\). In addition, \(a_i^* = 0\) and \(e_i^* = e_i(r_i^*) = (s_L + \Delta s\theta)\bar{y}/(2\gamma) - p/2(s_L + \Delta s\theta))\). Note that \(e_i^* > e_i^*\) and that \(e_i^* > 0\) by Assumption 1. \(\square\)

Proof of Lemma 2. Suppose the contrary, then there exists a profitable deviation for the \(L\)–type since \(r_i^* = \arg \max_{r_i > 0} V_L((a, r_i), \mu(L_i) = 1)\) for all \(a \geq 0\) and \(V_L\) is strictly decreasing in \(f\) (=additive separability of \(r\) and \(a\)). \(\square\)

Proof of Lemma 3. As shown in the proof of Lemma 1, (\(IR_H\)) will never be binding under limited liability at zero under given assumptions but the franchisee’s incentive constraint (\(IC\)) will always be binding. If (\(IC_{F_L}\)) is not trivially satisfied at \(w^*_H\), i.e., \(V_{LH}(w^*_H) > V_{LL}(w^*_L)\), then (\(IC_{F_L}\)) will be binding in the least–cost separating contract \(w^*_H\), i.e., \(V_{LH}(w^*_H) = V_{LL}(w^*_L)\). Suppose the contrary, then \(V_{LH}(w^*_H) > V_{LL}(w^*_L)\). If \(a^*_H > 0\), decreasing \(a^*_H\) raises both, \(V_{LH}(w^*_H)\) and \(V_{HH}(w^*_H)\) keeping the franchisee’s incentive constraint (\(IC_H\)) binding. This states a contradiction to least–cost separation for the interior solution case. If \(a^*_H = 0\) instead (corner solution case), decreasing the distance between \(r^*_H\) and \(r^*_H\) is strictly profit-enhancing for the \(H\)–type franchisor and reduces the slackness of the \(L\)–type’s franchisor constraint by strict concavity of \(V\). Hence, (\(IC_{F_L}\)) must be binding in the least–cost separating contract \(w^*_H\).

Next, we solve for the three remaining cases. First, if (\(IC_H\)) and (\(IC_{F_L}\)) are binding, and (\(LL_H\)) and (\(IR_H\)) are not binding (interior solution), then \(\hat{e}\) and \(a^*_H\) in (7) can be replaced by \(e_H(r) = (1 - r)(s_L + \Delta s)\bar{y}/\gamma\) solving (\(IC_H\)) and by \(a^*_H(r) = p_L(e_H(r))\bar{y}r - V_{LL}(w^*_L)\) rearranging.
(ICF₁). The transformed objective function equals \(p_H(e_H(r) - p_L(e_H(r))) \cdot \bar{y}r + V_{LL}(w_H^*)\) which is strictly concave in \(r\) by the assumptions on \(p_e(e)\) and \(c(e)\). Maximizing this objective function over \(r\), uniquely determines the least–cost separating royalty rate \(r_H^*\) for case 1 of the lemma. The reduction in franchise fee and the implied effort level are given by \(a_H^*(r_H^*) \) and \(e_H(r_H^*)\). From \(a_H^* = a_H^*(r_H^*) = \left(s_L^3 \Delta s \bar{y}^2 - \gamma^2 p^2\right)/(4y s_L^2) \geq 0\), \(\gamma_p^*\) can be derived by transforming the inequality. This leads to \(\gamma p < \gamma_p^* \equiv \bar{y} \sqrt{s_L^3 \Delta s}\).

Second, suppose \(\gamma p \geq \gamma_p^*\). Now, if (LLH), (ICH), and (ICF₁) are binding, and (IRH) is not binding (corner solution), substituting \(a_H^* = 0\) from (LLH) and \(e_H(r) = (1 - r)(s_L + \Delta s)\bar{y}/\gamma\) from (ICH) into (ICF₁) leads to \(p_L(e_H(r)) \cdot \bar{y}r = V_{LL}(w_H^*),\) where \(V_{LL}(w_H^*) = (\gamma p + s_L^2 \bar{y})^2/(4y s_L^2).\) This constraint determines the least–cost separating royalty rate \(r_H^*\) for case 2 since the maximizer of the objective function, \(\arg\max_r p_H(e_H(r)) \cdot \bar{y}r\), violates the constraint as \(p_H(e) > p_L(e)\). The modified (ICF₁)–constraint yields two solutions

\[
r_{1,2} = \frac{1}{2} + \frac{\gamma p}{2s_L(s_L + \Delta s)\bar{y}} \pm \frac{\sqrt{s_L \Delta s (s_L^3 (s_L + \Delta s)\bar{y}^2 - \gamma^2 p^2)}}{2s_L^2 (s_L + \Delta s)\bar{y}},
\]

the smaller of which maximizes the \(H\)–type franchisor’s expected utility, i.e., \(r_H^* = r_1\). From \(r_H^* < r_H^*, \gamma_p^*\) can be derived. Transforming this inequality leads to

\[
\gamma p < \gamma_p^* \equiv \bar{y} \sqrt{s_L^3 (s_L + \Delta s)^3 / (s_L^2 + 3s_L \Delta s + \Delta s^2)}.
\]

Finally, suppose \(\gamma p \geq \gamma_p^*\). Then, (ICF₁) is trivially satisfied by \(w_H^*\). Hence, \(w_H^*\) states the unique least–cost separating contract. Note that \(\gamma p \geq \gamma_p^*\) is not necessarily ruled out by Assumption 1.

**Proof of Lemma 4.** The optimality of least–cost separation, \(V_{HH}(w_H^*) \geq V_{HL}((0, r_{HL}^*))\), is necessary and sufficient for existence of a least–cost separating equilibrium. The case of interior solutions is covered in the main text. Next, we consider the case of corner solutions. It directly follows from Lemma 3 that in the case of corner solutions, \(V_{HH}(w_H^*)\) can be expressed as follows,

\[
V_{HH}(w_H^*) = (p + (s_L + \Delta s) \cdot e_H^*) \cdot \bar{y} \cdot r_H^*
\]

\[
= \left(\Delta s^2 \left(\gamma^2 p^2 + s_L^2 \bar{y}^2\right) + 2\Delta s \left(p \gamma s_L \Delta s (s_L^3 (s_L + \Delta s)\bar{y}^2 - \gamma^2 p^2) + \gamma p s_L^3 \bar{y} + s_L^2 \bar{y}^2\right) + s_L^3 (p \gamma + s_L^3)\bar{y}^2\right) / (4y s_L^3 (s_L + \Delta s)).
\]
Furthermore,

\[ V_{HL}(0, r^*_HL) = (p + (s_L + \Delta s) \cdot e^*_HL) \cdot r^*_HL = \frac{(s_L \bar{y}(s_L + \Delta s) + \gamma p)^2}{4\gamma s_L(s_L + \Delta s)}, \]

where \( r^*_HL \) and \( e^*_HL \) are given in the main text. Then, \( V_{HL}(0, r^*_HL) \) becomes equivalent to

\[ \frac{\Delta s p (\Delta s \gamma p + 2 s_L \Delta s(s_L^3(s_L + \Delta s)\bar{y}^2 - \gamma^2 p^2))}{4s_L^2(s_L + \Delta s)} \geq 0. \]

For \( \gamma_i \leq \gamma p < \gamma_2 \), the LHS of the this expression is well defined and strictly positive which finishes the proof.

**Proof of Proposition 2.** Given our results in Lemma 3, we have for interior solutions that \( r^*_H = 1/2 \) and for the corner solution that

\[ r^*_H = \frac{1}{2} + \frac{\gamma p}{2s_L(s_L + \Delta s)\bar{y}} - \frac{\sqrt{s_L \Delta s(s_L^3(s_L + \Delta s)\bar{y}^2 - \gamma^2 p^2)}}{2s_L^2(s_L + \Delta s)\bar{y}}. \]

By Lemma 1, it holds that \( r^*_H = 1/2 + \gamma p/(2(s_L + \Delta s)^2\bar{y}) \). First, it is obvious that for interior solutions, \( r^*_H \) is always smaller than \( r^*_H \). If we compare \( r^*_H \) for the corner solutions with \( r^*_H \), we receive that \( r^*_H \leq r^*_H \) is equivalent to

\[ \frac{(s_L + \Delta s) \sqrt{s_L \Delta s(s_L^3(s_L + \Delta s)\bar{y}^2 - \gamma^2 p^2)} - s_L \Delta s \gamma p}{2s_L^2(s_L + \Delta s)^2\bar{y}} \geq 0. \]

This inequality is always satisfied for \( \gamma p \leq \gamma_2 \). It is satisfied with equality for \( \gamma p = \gamma_2 \). Hence,
for $\gamma p < \gamma'_2$, it always holds that $r^*_H < r^*_H$. □

**Proof of Proposition 3.** If an equilibrium $\sigma \in M_H(\Sigma)$ is separating, then the unique least–cost separating contract $(w^*_L, w^*_H)$ will be selected. For $\sigma \in M_H(\Sigma)$ being pooling, both types of franchisor must choose this contract with probability one. A candidate for such a pooling contract is the optimal pooling contract for the $H$–type franchisor $w^p(\beta) = (0, r^p(\beta))$. This contract is unique. By construction of $w^p(\beta)$, $V^p_H(w^p(\beta)) \in [V^p_{HL}, V^p_{HH}]$ with $V^p_H(w^p(\beta)) = p_H(e^p(\beta))\bar{y}r^p(\beta)$. By optimality of least–cost separation, it holds that $V^p_H(w^p(0)) = V^*_H < V_H(w^*_H)$. Moreover, $V^p_H(w^p(1)) = V^*_{HH} > V_H(w^*_H)$, if the incentive constraint of the $L$–type franchisor is not trivially satisfied by $w^*_H$. Hence, by continuity of $V^p_H(w^p(\beta))$ in $\beta$, there exists a $\beta^c \in (0, 1)$ such that $V^p_H(w^p(\beta^c)) < V_H(w^*_H)$ for $\beta < \beta^c$ and $V^p_H(w^p(\beta)) \ge V_H(w^*_H)$ for $\beta \ge \beta^c$. Solving for $\beta^c$ in the interior solution case, we receive two solutions of a quadratic equation, a positive and a negative one, the latter of which we omit. The positive solution is equal to

$$\beta^c = \frac{1}{2s^2\Delta s\bar{y}^2(s_L + \Delta s)}\left(-s^2_L\bar{y}^2(s^2_L + s_L\Delta s - \Delta s^2) + \gamma^2p^2 \right. \left. + \sqrt{2\gamma^2p^2s^2_L\bar{y}^2(-s^2_L + s_L\Delta s + \Delta s^2) + s^4_L\bar{y}^4(s^2_L + s_L\Delta s + \Delta s^2)^2 + \gamma^4p^4}\right). \tag{11}$$

Furthermore, for $\gamma < \gamma'_1$, $\beta^c < 1$. In the case of corner solutions, a critical $\beta$ can be derived analogously. For brevity, we omitted this step.

It is left to show that for $\beta \ge \beta^c$ there exists a $\sigma \in M_H(\Sigma)$ which implements the $H$ type’s optimal pooling contract $w^p(\beta)$. This requires that the $L$–type franchisor also prefers to offer $w^p(\beta)$ rather than $w^*_L$, i.e. $V^*_L(w^p(\beta)) \ge V^*_L$ given pessimistic out–of–equilibrium beliefs. This condition is satisfied if and only if $\beta > \beta^*_L$, where, in the interior solution case,

$$\beta^*_L = \frac{1}{2s^2\Delta s\bar{y}^2(s_L + \Delta s)^2}\left((s_L + \Delta s)^2(\gamma^2p^2 - s^4_L\bar{y}^2) \right. \left. + \sqrt{-2\gamma^2p^2s^2_L\bar{y}^2(s_L + \Delta s)^2(s^2_L + 2s_L\Delta s - \Delta s^2) + \gamma^4p^4(s_L + \Delta s)^4 + s^4_L\bar{y}^4(s_L + \Delta s)^4}\right). \tag{12}$$

For $\gamma < \gamma'_1$, $0 < \beta^*_L < 1$. Comparing (11) and (12), lengthy calculations, which exploit that the square root in (11) is always larger than that in (12), show that for $\gamma < \gamma'_1$, $\beta^c \ge \beta^*_L$, which implies that $V^*_L(w^p(\beta^c)) \ge V^*_L$. Therefore, $M^* = M_L(M_H(\Sigma))$ selects the pooling contract for $\beta \ge \beta^c$ because $V^p_L(w^p(\beta)) > V^*_L$. □

**Proof of Proposition 4.** The proof follows directly from the functional form of $r^*_H$ and $r^p(\beta)$. For $\beta < \beta^c$, the royalty rate is $r^*_H = 1/2$, while, for $\beta \ge \beta^c$, the royalty rate is $r^p(\beta) = 1/2 + \gamma p/(2(s_L + \Delta s)(s_L + \beta \cdot \Delta s)\bar{y})$. $r^*_H$ is constant in $\beta$, whereas $r^p(\beta)$ is decreasing in $\beta$. In addition, $r^p(\beta) > r^*_H$ for all $\beta \in [0, 1]$, as the second term of $r^p(\beta)$ is positive for all $\beta \in [0, 1]$. □
**Proof of Lemma 5.** It has to be shown how the modified limited liability condition $a \geq -l = a_H^{FB}$ affects the implied effort level both, under observability of the outlet quality and under private information on the franchisor’s side.

We start with the case in which outlet quality is observable. Since the risk–neutral franchisee is not protected by limited liability under $(LL')$, the franchisor offers the first–best contract which fully sells the outlet to the franchisee. This results in $e_H^{FB}$.

When the franchisor is privately informed about outlet quality, then, at $a \geq -l = a_H^{FB}$, only the case of interior solutions arises. Since $(IC_H)$ and $(IC_{FL})$ are binding (cf. the proof of Lemma 3, interior solution), $\hat{e}$ and $f_H^*$ in (7) can be replaced by $e_H(r) = (1 - r)(s_L + \Delta s)\bar{y}/\gamma$ solving $(IC_H)$ and by $a_H^*(r) = p_L(e_H(r))\bar{y}r - V_{LL}(w_{FB})$ rearranging $(IC_{FL})$. The transformed objective function is equal to $(p_H(e_H(r)) - p_L(e_H(r))) \cdot \bar{y}r + V_{LL}(w_{FB})$. This leads to the same least–cost separating effort level as in Lemma 3 since the transformed objective function differs from that in Lemma 3 only by a constant. □
References


Web Appendix: Complements and Substitutes

We next present a more general version of our model which allows for a varying degree of complementarity between effort and outlet type, by including a multiplicative term (complements) as well as an additive one (substitutes), i.e., \( \tilde{p}_i(e) = (p + \Delta p \theta_i) + (s_L + \Delta s \theta_i) \cdot e \), with \( \Delta p \geq 0 \). We can show that our reduced royalty rate result from Proposition 2 carries over to the more general case if the degree of complementarity is not too low (i.e., the additive component is not too large). Otherwise, the information asymmetry can well lead to an increase in royalty rates as, for example, found by Inderst (2001) who considers a purely additive relationship. Note also that the proof of the next proposition does not require our functional form assumptions on \( \tilde{p}_i(e) \) and \( c(e) \) nor that \( \tilde{p}_i(e) \) is an affine function of \( \theta_i \). But as proving existence without functional forms is very difficult in our setup (see Lemma 6), we refrained from using a more general model.

**Proposition 5.** Suppose \( \tilde{p}_i(e) \) and \( c(e) \) are such that the incentive constraint of the L–type franchisor is not trivially satisfied by \( w^*_H \). Then in the game with less prior information, the equilibrium royalty rate \( r^*_H \) in the least–cost separating contract \( w^*_H \) is lower than the second-best royalty rate \( r^*_H \) under symmetric full information), if and only if

\[
\eta_H(e^*_H) > \eta_L(e^*_H). \tag{13}
\]

\( \eta_i(e) \equiv e \cdot \tilde{p}'_i(e)/\tilde{p}_i(e) \) is defined as the effort elasticity of the success probability function of outlet \( i \) at effort \( e \). The corresponding franchise fee \( a^*_H \) and royalty rate \( r^*_H \) are determined analogously to Lemma 3 applying \( \tilde{p}_i(e) \) instead of \( p_i(e) \).

The effort elasticity of the success probability function reflects the franchisor’s trade–off between a higher marginal success probability and a lower marginal royalty rate for a marginal increase in effort.\(^{31} \) If the net effect of such a marginal increase in effort is larger for the \( H \)–type franchisor than for a mimicking \( L \)–type franchisor at the second-best effort level for good outlets \( e^*_H \), then the \( H \)–type franchisor will increase the induced effort level in the least–cost separating contract by reduced royalty rates. This demonstrates a situation with a high degree of complementarity between effort and outlet type.

**Proof of Proposition 5.** First, consider the first-order condition of the \( H \)–type franchisor’s problem for interior solutions (= case 1 of Lemma 3) which determines \( r^*_H \), the least–cost separating royalty rate. Suppose that \( \left( \tilde{p}'_H(e) - \tilde{p}'_L(e) \right) \tilde{y} r_H(e) + \left( \tilde{p}_H(e) - \tilde{p}_L(e) \right) \tilde{y}' r'_H(e) \geq 0 \) at \( e = e^*_H \), where \( r_i(e) = 1 - c'(e)/\tilde{p}'_i(e) \tilde{y} \) is derived from the franchisee’s problem.

\(^{31}\)Cf. the first-order condition of the \( H \)–type franchisor’s problem in case 1 of Lemma 3.
Rearranging yields
\[
\frac{(\tilde{p}'_H(e^*_H) - \tilde{p}'_L(e^*_H))}{(\tilde{p}_H(e^*_H) - \tilde{p}_L(e^*_H))} \geq \frac{-r'_{H}(e^*_H)}{r_H(e^*_H)}.
\]

Using the \( r_i(e) \)–notation and maximizing over \( e \), leads to the following first-order condition of the \( H \) type’s problem under outlet observability, \( \tilde{p}'_i(e)\tilde{y}_r(e) + \tilde{p}_i(e)\tilde{y}'_r(e) = 0 \) (cf. Lemma 1). This is equivalent to
\[
\tilde{p}'_H(e^*_H) = \frac{r'_{H}(e^*_H)}{r_H(e^*_H)}.
\]

Substituting this equation into the previous inequality and simplifying yields
\[
\frac{\tilde{p}'_H(e^*_H)}{\tilde{p}_H(e^*_H)} \geq \frac{\tilde{p}'_L(e^*_H)}{\tilde{p}_L(e^*_H)}.
\]

By multiplying with \( e^*_H \), we get the elasticity condition \( \eta_H(e^*_H) > \eta_L(e^*_H) \), where \( \eta_i(e) \equiv e \cdot \tilde{y}_r(e) / \tilde{y}_l(e) \) is defined as the effort elasticity of outlet \( i \)’s success probability function at effort \( e \). We conclude that \( \left( \tilde{p}'_H(e) - \tilde{p}'_L(e) \right) \tilde{y}_r(e) + \left( \tilde{p}_H(e) - \tilde{p}_L(e) \right) r'_H(e) \geq 0 \) at \( e = e^*_H \) corresponds to \( r'_H \geq r'_H \) by strict concavity of the franchisor’s expected utility in the least–cost separation case (see proof of Lemma 3).

In case 2 of Lemma 3, i.e. if also \( LL_H \), besides \( IC_H \) and \( IC_H \), is binding, the interior solution from above does not exist. However, by continuity of the franchisor’s expected utility function, the selection condition in case 2 picks the royalty rate with the corresponding properties, i.e. \( r'_H < r'_H \) if and only if \( \eta_H(e^*_H) > \eta_L(e^*_H) \).

The previous proposition uses only a local property of the success probability functions \( \tilde{p}_H(e) \) and \( \tilde{p}_L(e) \) at \( e = e^*_H \). It can be shown however that under the current assumptions, the sign of \( \eta_H(e) - \eta_L(e) \) is globally constant, i.e., for all \( e \in [0, \tilde{e}] \).

**Corollary 5.1.** For \( \tilde{p}_i(e) = (p + \Delta p \theta_i) + (s_L + \Delta s \theta_i) \cdot e \) with \( \theta_L = 0 \) and \( \theta_H = 1 \) the sign of \( (\eta_H(e) - \eta_L(e)) \) is constant for all \( e \). It is positive if and only if \( \Delta s / \Delta p > s_L / p \).

This implies that even for \( \Delta p < p \cdot \Delta s / s_L \) but \( \Delta p > 0 \), the degree of complementarity between effort and project type is sufficiently high in order to render reduced royalty rates optimal.
Proof of Corollary 5.1.

\[
\eta_H(e) > \eta_L(e) \iff \frac{p_H'(e)}{p_H(e)} > \frac{p_L'(e)}{p_L(e)} \iff \\
\frac{(s_L + \Delta s)}{(p + \Delta p) + (s_L + \Delta s) \cdot e} > \frac{s_L}{p + s_L \cdot e} \iff \\
\frac{p}{s_L} > \frac{(p + \Delta p)}{(s_L + \Delta s)} \iff \\
\frac{p}{s_L} + e > \frac{(p + \Delta p)}{(s_L + \Delta s)} + e \iff \\
\frac{p}{s_L} > \frac{(p + \Delta p)}{(s_L + \Delta s)} \iff \\
ps_L + p\Delta s > ps_L + \Delta ps_L \iff \\
\frac{\Delta s}{\Delta p} > \frac{s_L}{p},
\]

which is independent of \(e\) and \(\theta_H\). □

Finally, the next lemma shows that in the more general case considered in this Web Appendix, a least–cost separating equilibrium still exists if the degree of complementarity between effort and project type is not too low.

Lemma 6 (Optimality of Least–Cost Separation: More General Case). Suppose outlet type \(i\) is unobservable and the franchisee holds pessimistic beliefs besides the least–cost separating contract, \(\mu(H|w \neq w^*_H) = 0\). The \(H\)–type franchisor prefers the least–cost separating contract, \(w^*_H\), to the optimal non–separating contract, \((0, r^*_{HL})\), i.e. \(V_{HH}(w^*_H) > V_{HL}((0, r^*_{HL}))\) if and only if \(\Delta p\) is weakly lower than the critical level \(\Delta p^c\) with \(\Delta p^c > p \cdot \Delta s/s_L\).

This shows that in the more general case with \(\Delta p \geq 0\), also least–cost separating equilibria, which induce an increased royalty rate, can exist.

Proof of Lemma 6. Considering the more general success probability function, it can be shown that for the interior solution case, \(V_{HH}(w^*_H)\) and \(V_{HL}((0, r^*_{HL}))\) equal

\[
V_{HH}(w^*_H) = ((p + \Delta p) + (s_L + \Delta s) \cdot e_H^* \cdot \bar{y} \cdot r_H^* - a_H^*)
\]

\[
= \gamma^2 \left( \frac{\Delta p^2}{\Delta s (s_L + \Delta s)} + \frac{\bar{y}^2}{s_L^2} \right) + 2\gamma \bar{y} (p + \Delta p) + \bar{y}^2 \left( s_L^2 + s_L \Delta s + \Delta s^2 \right)
\]

\[
4\gamma
\]
and

\[
V_{HL}(0, r^*_{HL}) = ((p + \Delta p) + (s_L + \Delta s) \cdot e^*_{HL}) \cdot \bar{y} \cdot r^*_{HL} \\
= \frac{(s_L(s_L + \Delta s)\bar{y} + \gamma(p + \Delta p))^2}{4\gamma s_L(s_L + \Delta s)}
\]

For interior solutions, the necessary and sufficient condition for optimality of least–cost separation, \(V_{HH}(w^*_{HH}) \geq V_{HL}(0, r^*_{HL})\), becomes equivalent to

\[
\gamma \left( \Delta p^2 s_L^2 - \Delta p \Delta s s_L (\Delta p + 2p) + \Delta s^2 p^2 \right) + \frac{\Delta s^2 \bar{y}^2}{\gamma} \geq 0 \tag{14}
\]

The inequality collapses to \(\gamma p \leq \bar{y} \sqrt{s_L^3(s_L + \Delta s)}\) for \(\Delta p = p \cdot \Delta s/s_L\). Hence, it is satisfied for \(\Delta p = p \cdot \Delta s/s_L\) if the moral hazard problem is not too severe. For \(\Delta p > p \cdot \Delta s/s_L\), it can be shown that (14) remains strictly positive as long as the difference between \(\Delta p\) and \(p \cdot \Delta s/s_L\) does not become too large. The critical level of \(\Delta p\) is equal to

\[
\Delta p^c \equiv \frac{\sqrt{\Delta s^3(s_L^3 \gamma^2 (s_L + \Delta s^2) + 2p^2)} - \Delta s \gamma p}{\gamma (s_L - \Delta s)}.
\]

A similar argument can be made for the corner solution case.

We finally conjecture that even without \(\tilde{p}_i(e)\) being an affine function of \(\theta_i\), there will be optimality of least–cost separation for \(\tilde{p}_H(0)\) being not too high relative to \(\tilde{p}_L(0)\) and \(\tilde{p}'_H(e) > \tilde{p}'_L(e)\).