Contestable Licensing*

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Abstract

We analyze a model of repeated franchise bidding for natural monopoly with contestable licensing – a franchisee holds an (exclusive) license to operate a franchise until another firm offers to pay more for this license. In a world where quality is observable but not verifiable, the simple regulatory scheme we describe combines market-like incentives with regulatory oversight to generate efficient outcomes.

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1. Introduction

We analyze a model of (repeated) franchise bidding for natural monopoly that relies on contestable licensing – the right to operate the franchise belongs to the party who owns the appropriate license as long as the license is not successfully contested through a process of competitive bidding – and demonstrate the usefulness of contestable licensing in inducing high quality performance from incumbent franchisees. In a world where quality is observable but not verifiable, the simple regulatory scheme we describe combines market-like incentives with regulatory oversight to generate efficient outcomes.

Our analysis builds on the "Chicago approach" to regulating a natural monopoly (Demsetz (1968), Stigler (1968), and Posner (1972)).[1] We consider a natural monopoly franchise such as cable television, garbage collection, electric power generation, or railroad operation. Every period, the incumbent monopolist (franchisee) may either provide high quality service which yields a "normal" rent, or low quality service, which results in a correspondingly higher per-period payoff for the monopolist. We assume that consumers benefit from high quality service, and moreover, providing high quality service is also efficient. The quality of service is observable by the relevant regulatory agency, but it is not verifiable in court. We assume that, because of this non-verifiability, the political economy environment in which the regulator operates does not allow it to credibly commit to transfer the franchise to another firm upon observation of low quality service.[2,3]

At this stage, it is useful to abstract away from considerations of pricing and the ability of the regulator to observe other variables besides quality (e.g., cost and sales). As will become clearer below, such considerations are orthogonal to the main part of our discussion.

[1] Williamson (1976) famously criticized the "Chicago approach" for what he claimed was their sanguine dismissal of the related issues of sunk costs, the incentives to invest, the transferability of investment and asset specificity. We take up this criticism, and explain the way in which our approach deals with these issues in Section 4 below.

[2] It is not difficult to see that with such commitment power, the regulator can guarantee efficient operation by relying on a "grim-trigger" strategy. See, e.g., Klein and Leffler (1981).

[3] This can be due to two reasons: First, the regulator may be subject to "regulatory capture." It may capitulate to the franchisee even though the latter consistently provides low quality service. (See, e.g., Laffont and Tirole (1994) and the references therein.) Second, lawmakers may prevent the regulator from dismissing the franchisee at will in order to constrain the regulator's ability to demand illegal kickbacks from a monopolist who wishes to retain the franchise.

We consider a model where every period a rival firm may contest the right of the incumbent franchisee to operate the franchise by making a bid for the license to operate the franchise. The incumbent franchisee may submit a counter-bid, and whoever made the highest bid wins the right to operate the franchise until the next challenger appears, upon which the whole process is repeated. We describe conditions under which a franchisee who provides low quality service is quickly replaced by another in equilibrium. On the other hand, a franchisee who provides high quality service, can expect to hold the license for a long period of time. Thus, when the incumbent franchisee considers the present value of providing high versus low quality service, the former yields a higher payoff. As a result, franchisees who intend to provide high quality service are also willing to pay more for the license, and they always win the bidding contest against opponents who have the same technological capability but intend to provide low quality service. Furthermore, under some additional plausible assumptions that are described below, this is the *only* pattern of behavior that is consistent with subgame perfect equilibrium.

The regulator's role in all of this is important but minimal: First, it must design the franchise contract in a way that allows a franchisee who provides high quality service for a long period of time to earn higher (discounted) profits than a franchisee who provides low quality service for a short period of time.[4] Second, if a rival firm is willing to pay more for the license than the incumbent franchisee, then the regulator awards it with the right to operate the franchise; if the incumbent is willing to pay more than the rival firm, then it retains the license. Only when the rival firm and the incumbent franchisee are willing to pay equal amounts for the license, is the regulator called to exercise judgement. In this case, the regulator should award the license to the incumbent franchisee if it provided high quality service in the past, and to the rival firm if the incumbent provided low quality service in the past.

Our analysis gives rise to a number of interesting conclusions. First, the formal separation in the model between the issue of the quality of service on the one hand, and the price and cost of operation on the other hand, allows us to describe a regulatory scheme that permits the combination of assuring high quality service together with the provision of "high-powered" incentives.[5] This is due to the fact that, as we show below, contestable licensing ensures

[4]For any given interest rate, this can be easily acheived by adding a sufficiently large constant to the per-period transfer from the regulator to the incumbent franchisee.

[5]Incentives are "high powered" if the regulated firm is allowed to capture a large fraction of its cost

high quality service, and it allows the regulator, in addition, to design a separate incentive scheme that is highly responsive to the franchisee's cost savings and sales. In contrast, much of the literature has emphasized that high quality performance necessitates the provision of low powered incentives.[6]

Second, repeated competitive bidding allows the regulator to encourage entry of more efficient firms, and puts pressure on the incumbent franchisee to innovate and invest in improving its technological capability.[7,8]

Third, unlike Demsetz (1968) and Stigler (1968) that call for awarding the franchise to the firm that offers to supply the service on the best terms,[9] or Posner (1972) that recommends that firms compete for the license through bids that combine terms of service and lump sum transfers, we show that the incentives to provide high quality service are better preserved when the franchise is awarded to the firm that is offering to pay the largest lump sum for it. Previous authors emphasized that once a monopolist obtains exclusive right to operate a franchise through competition, it has an incentive to provide low quality service unless the competition was specifically on the terms of the franchise contract. We highlight a different concern. Namely, competition over the terms of the franchise service could encourage "hit-and-run" operators who offer excellent terms of service, but provide very low quality service, and disappear after having made their profit.

Fourth, following the Chicago approach and unlike Laffont and Tirole (1988), we show that the preservation of dynamic incentives is better served with the imposition of bidding parity between the incumbent franchisee and the rival firm.[10]

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savings. They are "low powered" if the opposite is true.

[6] Laffont and Tirole (1994) for example write "When incentives for noncontractible quality are provided by reputational concerns, low-powered incentives are needed to encourage its provision." (p. 664) See also Laffont and Tirole (1991) and the references therein.

[7] On this account, we differ from Stigler (1968) and Demsetz (1968) who considered competition for once-and-for-all contracts or (incomplete) long term contracts, respectively.

[8] Previous authors have also emphasized the fact that the flexibility afforded by repeated short-term contracting allows the regulator to adjust for new, non-contracted-for circumstances (see, e.g., Williamson (1985, p. 339)). However, we do not address this important advantage of repeated contracting formally in our model.

[9] This is also the maintained assumption in the more formal franchise bidding literature surveyed below.

[10] Laffont and Tirole (1988) considered a two-period model where distortion away from bidding parity in the second period improves efficiency by affecting the incumbent franchisee's incentives to invest in the first period.

Fifth, as a consequence of the fact that, in equilibrium, an incumbent franchisee that provides high quality service can expect to remain the incumbent for a relatively long period of time, the "dynamic costs" associated with the fact that incumbent franchisees may underinvest in capital equipment for fear they will not be able to recoup their investment in case they are replaced, need not be large.[11]

Finally, because on the equilibrium path, the incumbent franchisee is never challenged, the transaction costs associated with running a series of bidding contests need not be large either.[12]

The analysis presented here relates to the previous theoretical literature on franchise bidding (Laffont and Tirole (1987), McAfee and McMillan (1987), and Riordan and Sappington (1987)).[13] This literature has mostly considered once-and-for-all bidding,[14] and focused on the "separation" between the competitive bidding stage and the regulation stage, obtaining the result that the winner of the franchise can be regulated as if the competition did not take place. Our focus is different. In contrast to this previous literature which studied franchise bidding under asymmetric information but with "complete contracting" ability, we consider a situation with complete information but incomplete contracting ability. In this environment, we show that allowing for repeated franchise bidding exerts a strong disciplinary pressure on the incumbent franchisee to provide high quality service and invest in improving its technology.

Another related work is that of Klein and Leffler (1981) who studied the issue of whether the market mechanism (repeat-purchase) can be counted on to ensure high quality performance in those circumstances where quality is not directly contractible. The necessary and sufficient condition they identified, namely, that market prices are set high enough so that the discounted stream of rents to the firm with high quality performance is greater than the rents obtained from nonperformance, has a direct analog in our model (RR1 below). However, while this condition is necessary in our model as well, it is not sufficient.

Finally, the basic idea of "contestable licensing" shares at least some of its motivation with the idea of "contestable markets" as formulated in Baumol, Panzar and Willig (1982)

[11] See Williamson (1976) and Laffont and Tirole (1988).

[12] See Williamson (1976).

[13] See also Laffont and Tirole (1994) and the references therein.

[14] However, as mentioned above in footnote 6, Laffont and Tirole (1988) considered the case of twice repeated bidding. Riordan and Sappington (1989) offer related analysis.

and the references therein. Both rely on the notion of contestability to discipline incumbent firms. However, there are several important differences between the two approaches. A perfectly contestable market is one where all producers have access to the same technology that does not involve sunk costs. Neither of these assumptions is required in our model. Perhaps more importantly, we are interested in a different question. While the contestability literature formulates conditions under which regulatory intervention (except for securing easy entry and exit) is unnecessary, and derives implications with respect to market structure, our goal is to utilize the idea of contestability for the purpose of designing a regulatory scheme that calls for much greater regulatory oversight.

The rest of the paper proceeds as follows. In the next section we present the model. In Section 3, we proceed to describe our assumptions about the regulator's and firms' strategic behavior. We describe the (unique) subgame perfect equilibrium and provide some (counter-) examples. In Section 4, we discuss the robustness of our results to the introduction of uncertainty and the issues of sunk costs, the transferability of investment and asset specificity. Brief concluding comments are presented in Section 5. All proofs are relegated to the Appendix.

2. The Model

Let J be a large set of risk-neutral firms that are all potentially capable of operating some natural monopoly franchise. We assume that the firms' per-period opportunity costs are identical and equal to zero. A firm's technological capability at a given point in time is summarized by a real number $a \in \{a_1, a_2, ...\}$, where $a_{k+1} > a_k$ for every $k \geq 1$. The higher is a, the more advanced is the firm's technology. We model technological progress in the following way: the set of technologies available at any period $t \geq 1$ is exogenously given by $\{a_1, ..., a_t\}$. We assume that in any period t, a firm with technological capability $a_k \in \{a_1, ..., a_t\}$ may invest an amount $c_t \geq 0$ to ensure that it will have a technological capability a_{k+1} in period $t+1$. A firm that does not invest in technological improvement retains its current technological capability.[15]

Every period, the incumbent franchisee chooses whether to provide high or low quality

[15] The deterministic nature of technological progress in our model is motivated by the fact that we view the investment in technological improvement as an attempt to keep up with current state-of-the-art technology, rather than as innovative path-breaking research. See also the discussion in Section 4 below.

service. The incumbent's choice of quality in period t is denoted by $q_t \in \{q_L, q_H\}$ where q_L denotes low and q_H denotes high quality service, respectively.[16] For example, a firm can provide low quality service by taking advantage of its monopolistic power and pricing "highly," by not installing a large enough capacity to handle emergency situations, etc. We assume that the incumbent franchisee's choice of quality is observable by the regulator but not verifiable in court.[17]

The social welfare generated by the incumbent franchisee in period t (which we identify with the regulator's per-period objective function) is given by $w_t = w_t(a_t, q_t)$. We assume that for every $t \geq 1$, $w_t(\cdot, \cdot)$ is increasing in the incumbent franchisee's technological capability a_t (as this implies lower cost for consumers) and in the quality of service. That is, other things being equal, a more technologically advanced incumbent franchisee and an incumbent franchisee that provides high quality service generate a higher per-period social welfare.

The payoff to the incumbent franchisee in period t depends on the terms of the license to operate the franchise in period t (which is determined by the regulator) and on the incumbent franchisee's choice of quality. It includes a transfer to or from the regulator that may depend on the franchisee's technological capability, cost observation, sales, etc., as stipulated in the franchise contract, the cost incurred by the franchisee,[18] and the revenue collected by the franchisee. We denote the per-period profit to the incumbent franchisee in period t by $\pi_t(a_t, q_t)$ and assume that for every $t \geq 1$, the regulator sets the terms of the license such that $\pi_t(\cdot, \cdot)$ is increasing in the incumbent franchisee's technological capability. We also assume that $\pi_t(\cdot, \cdot)$ is decreasing in the quality of service. This is an immediate consequence of the fact that quality is not verifiable. As much as it would like to, the regulator cannot reward the franchisee for providing high quality service. Thus, other things being equal, a more technologically advanced incumbent franchisee and an incumbent franchisee that provides lower quality service obtain a higher per-period payoff.

[16] In many applications, quality is likely to be multi-dimensional. This does not affect our results as long as there exists a monotone function that maps quality into $\{q_L, q_H\}$. The fact that we only distinguish between high and low quality involves no loss of generality since the "efficient" quality (and higher qualities) can be mapped into q_H, and lower qualities into q_L.

[17] It follows that the regulator cannot "punish" the franchisee by, say, terminating the franchise contract upon observation of low quality service. We thus implicitly assume that the regulator can enforce high quality service in all those (unmodelled) dimensions where quality is verifiable.

[18] This cost does not include possibly large, but infrequently incurred, set-up costs. These are discussed seperately in Section 4 below.

We assume that the firms and the regulator discount all future payoffs according to the commonly known (real) interest rate, $r > 0$.

We do not specify the terms of the franchise contract that are independent of the franchisee's choice of quality. However, we do assume that every such term can be enforced. While we abstract from such considerations in the paper, note that the regulator may adapt the terms of the franchise contract in every period to suit changing conditions. This formal separation allows us to obtain our conclusions about the possibility of providing "high powered" incentives together with the assurance of high quality service.

The game proceeds as follows. In every period $t \geq 1$:

1. The incumbent franchisee decides whether or not to provide high quality service and whether to undertake a technology enhancing investment c_t.

2. At the end of the period, the payoff to the incumbent franchisee and social welfare to society are realized.

3. Next, a rival firm appears. We assume that the rival firm has a better technology than the incumbent's if such a better technology exists.[19] Otherwise, we assume that the rival firm has the same technological capability as the incumbent's.[20] The rival firm may bid for the license to operate the franchise. We denote its bid by $b_t^C \geq 0$. We assume that preparing and submitting the bid requires the rival firm to incur a small cost, μb_t^C, which is proportional to its bid. Finally, the challenger's bid is constrained to be an integer multiple of some bid increment $m > 0$ that is assumed to be small relative to the advantage conferred by better technological capability, or $\pi_t(a_t, \cdot) - \pi_t(a_{t-1}, \cdot)$, for every $t \geq 1$.[21]

4. The incumbent franchisee may respond by making a counter-bid $b_t^I \geq 0$ at a cost μb_t^I. The counter-bid b_t^I is constrained to be an integer multiple of the bid increment m.

[19] There is no need to specify how much better the rival firm's technology is. As Lemma 3 below shows, in equilibrium, more technologically advanced firms always defeat less technologically advanced firms.

[20] The details of the analysis can be easily modified to accomodate the case where the rival firm's technological capability is lower than that of the incumbent's.

[21] This constraint is introduced for the purpose of ensuring that maximization problems have well defined solutions.

5. The regulator awards the franchise to the highest bidder, provided (exactly) one exists. The regulator's action in case the bids are tied is specified below in the second regulator's rule.

It is understood that the right to operate the franchise belongs to the incumbent franchisee as long as the terms of the franchise contract are satisfied, and the regulator did not award the right to operate the franchise to another firm through competitive bidding as specified above.

Thus, a full description of play at time t is summarized by a vector $\left(a_\tau, q_t, \gamma_t, \pi_t(a_t, q_t), w_t(a_t, q_t), b_t^I, b_t^C\right)$ which describes the incumbent franchisee's technological capability, choice of quality, investment $\gamma_t \in \{0, c_t\}$, payoffs to the incumbent franchisee, the social welfare generated, and the incumbent's and the challenger's bids. A history of play up to and including time t, denoted h_t, is given by a sequence $\left\{\left(a_\tau, q_\tau, \gamma_\tau, \pi_\tau(a_\tau, q_\tau), w_\tau(a_\tau, q_\tau), b_\tau^I, b_\tau^C\right)\right\}_{\tau=1}^{t}$ Notice that the description of play at time t does not include the "names" of the incumbent and challenger firms. Thus, firms' strategies are constrained to depend only on their own and the incumbent franchisee's technological capability, the incumbent franchisee's tenure as the incumbent, and performance, not on firms' names. The consequences of relaxing this anonymity assumption are discussed further in Example 2 below.[22]

3. Equilibrium Analysis

3.1. "Pure" Moral Hazard

For expositional purposes, we confine our attention in this subsection to the simpler "pure" moral hazard problem. That is, we assume that all firms have equal technological capabilities and focus on the franchisees incentives to provide high quality service.[23]

We present a number of assumptions under which providing high quality service is the unique subgame perfect equilibrium outcome of the game above. The subgame perfect equilibrium we describe is such that a franchisee that provides low quality service, while

[22] The assumption of anonymity may be interpreted as an assumption about the "degree of competitiveness" of the underlying economic environment. See the discussion in Osborne and Rubinstein (1990), and Rubinstein and Wolinsky (1990).

[23] It does not matter whether we assume that there is technological progress but $c_t = 0$ for every $t \geq 1$, or whether we assume that there is no technological progress.

earning a higher per period payoff, can only expect to remain the incumbent franchisee for one period. On the other hand, an incumbent franchisee that provides high quality service (and earns a lower per period payoff), can expect to remain the incumbent forever. For this indeed to be sustained as an equilibrium, the regulator has to behave in accordance with the following rule:

Regulator's Rule 1. (RR1) *The regulator sets the terms of the contract such that the payoff to the franchisee from providing low quality service for one period is lower or equal to the discounted sum of benefits associated with providing high quality service forever. Or, for every* $t \geq 1$,

$$\sum_{\tau=1}^{\infty} \left(\frac{1}{1+r}\right)^{\tau} \pi_{t+\tau}\left(a_{t+\tau}, q_H\right) \geq \left(\frac{1}{1+r}\right) \pi_{t+1}\left(a_{t+1}, q_L\right). \qquad (*)$$

It is important to observe that the rule above can be easily followed. Suppose for example that the regulator sets exactly the same contract every period, and that this contract generates per-period profits of $\overline{\pi}$ and $\underline{\pi} < \overline{\pi}$ to the franchisee if it provides low and high quality service, respectively. In this case $(*)$ reduces to

$$\frac{1}{r} \cdot \underline{\pi} \geq \frac{1}{1+r} \cdot \overline{\pi},$$

which is satisfied whenever the interest rate r is low enough. In case the interest rate is not sufficiently low, the regulator can still ensure that $(*)$ is satisfied by allowing the franchisee to capture a rent that is higher by T in every period.[24] Note also that the regulator would typically want to set the left-hand-side of $(*)$ to be as low as possible in order to minimize the rent captured by the incumbent franchisee.

The next rule further constrains the regulator's behavior. Recall that if either the incumbent franchisee or its rival make a higher bid for the license to operate the franchise, the regulator awards it with the license. It is possible however, that they bid exactly the same amount. In this case we assume that the regulator awards the license to the rival firm if the incumbent franchisee provided low quality service in the last period, but it lets the incumbent franchisee retain the license if the incumbent provided high quality service in the last period. In an environment where quality is non-verifiable and hence not directly contractible, this provides an easily justifiable way for the regulator to discipline the incumbent franchisee.

[24] Thus, as in Klein and Leffler (1981), it is necessary to let the incumbent franchisee capture a positive rent to assure high quality performance.

Regulator's Rule 2 (RR2, "Tie-Breaking Rule"). *If at (the end of) any period t the rival firm and the incumbent franchisee bid the same amount $b_t^I = b_t^C$ for the license, then the regulator awards the license to the incumbent if it provided high quality service in period t, and to the rival firm if the incumbent provided low quality service in period t.*

Together, RR1 and RR2 ensure that providing high quality service is an equilibrium of the game. The next two assumptions describe restrictions on the strategies of the firms in the game that ensure that providing high quality service is the unique subgame perfect equilibrium outcome of the game. The next assumption imposes a restriction on what rival firms consider to be relevant history.

Assumption 1 ("Rival firms care only about the performance of the incumbent franchisee"). *When bidding for the license, rival firms' decisions about how much to bid depend only on what has happened since the current incumbent franchisee began operating the franchise.*

That is, we assume that rival firms ignore everything that has happened before the current incumbent franchisee has started operating the franchise. We also assume,

Assumption 2 ("Firms have bounded recall"). *Firms do not remember what happened more than k periods ago for some finite $k \geq 1$.*

This is a standard "bounded rationality" type assumption. Note that the length of firms' recall, k, can be arbitrarily large. We have the following result,

Proposition. *Suppose that firms have equal technological capabilities, the regulator follows RR1 and RR2, and Assumptions 1 and 2 are satisfied. Then, the game described above has a generically unique subgame perfect equilibrium. In this equilibrium, the incumbent franchisee always provides high quality service and is never challenged.*[25]

The strategies that support this unique subgame perfect equilibrium are as follows: The incumbent franchisee provides high quality service in every period. Whenever it is challenged, it matches any bid that is equal or below the discounted sum of payoffs from providing high quality service taking the cost of bidding into account. If a higher bid is submitted, the incumbent declines to bid. Rivals' strategies are as follows. If at any period, the incumbent franchisee provided low quality service, then the next rival firm bids an amount equal to the

[25] We use the term "generically" in the following sense: the franchisee's payoff $\pi_t(\cdot,\cdot)$ is generically not equal to some integer multiple of the bid increment m.

discounted sum of payoffs from providing high quality service taking the cost of bidding into account. Rival firms decline to bid otherwise. Along the equilibrium path, the incumbent franchisee always provides high quality service and is never replaced.

It is easy to verify that this is indeed a subgame perfect equilibrium. By providing low quality service, the incumbent franchisee runs the risk that a rival firm, will bid for the license and win since it is favored by the regulator's tie-breaking rule. RR1 then implies that the maximum profit that the incumbent franchisee can achieve by providing low quality service for one period is lower than the sum of discounted profits if it continues to provide high quality service forever.

However, this does not explain why this is the *unique* subgame perfect equilibrium. For example, one may speculate that the incumbent franchisee can provide low quality service but the next rival firm may be wary of challenging it because the rival firm believes that if it becomes the incumbent franchisee itself, it would be challenged by future rival firms and have to pay to keep its license whereas the incumbent franchisee would not. As a consequence, the rival firm would be willing to pay less for the license and since bidding is costly, would not attempt to bid for the license. The proof of the proposition shows that such wariness on the part of rival firms is incompatible with the logic of subgame perfect equilibrium.

Because firms have bounded recall, the rival firm that appears in period t, call it j, knows that if it survives k periods as the incumbent franchisee (i.e., it is the incumbent franchisee at $t+k+1$) it will be treated thereafter exactly as the present incumbent franchisee, call it i, would. Therefore, k periods into the future (i.e., in period $t+k$), j would be willing to pay the same amount the incumbent franchisee i would for the right to operate the franchise in period $t+k+1$. Assumption 1 implies that the rival firm that will appear in period $t+k$ (challenging the incumbent franchisee of period $t+k$ for the license in period $t+k+1$ onwards) will only be judged according to its own performance. It will therefore be indifferent between challenging firm j or the incumbent franchisee i and will therefore treat both identically. Realizing this, firm j would also realize that it faces the exact same future as the incumbent franchisee i, k rather than $k+1$ periods into the future. The same argument can be repeated to show that firm j would be treated exactly as the incumbent franchisee also $k-1$ periods into the future. Repeating this argument $k-2$ more times implies that the rival firm j and the incumbent franchisee can expect to be treated in the same way by all future rival firms. But, if this is the case, an incumbent franchisee who

chooses to provide low quality service gives up its advantage as the incumbent and is surely going to be defeated by the next rival firm. On the other hand, if it chooses to provide high quality service, it can count on the regulator's "support" and will win every future contests by matching rival firms' bids. All rival firms realize this and therefore, since bidding is costly, decline to bid against incumbent franchisees that provided high quality service in the past.

We conclude this subsection by presenting two (counter-) examples that illustrate the significance of our focus on subgame perfect as opposed to Nash equilibria, and on anonymity. Our assumptions (namely, RR1, RR2, and Assumptions 1-2) are all necessary in the sense that counter-examples where all but one other assumption are satisfied and yet a subgame perfect equilibrium where low quality service is provided in every period exists. The fact that the equilibria described in these examples are "pathological" (for reasons that will be explained below) lends support to the robustness of our conclusions.

In all of the examples below, it is assumed that all firms have the same technological capability a, and that the regulator sets the same franchise contract in every period. The statement "bid B" should be interpreted as "bid the highest integer multiple of the bid increment m that is smaller or equal to B." We denote the (stationary) per-period payoff of an incumbent franchisee that provides low quality by $\overline{\pi}$, and of an incumbent franchisee that provides high quality service by $\underline{\pi}$. By assumption, $\overline{\pi} > \underline{\pi} > 0$.

Example 1 (Subgame perfect vs. Nash equilibrium). Consider the following profile of strategies: The strategy of every rival firm is to always challenge the incumbent franchisee by bidding $\frac{\overline{\pi}}{(1+\mu)(1+r)}$. The strategy of every incumbent franchisee is to provide low quality service after any history. When challenged, every incumbent franchisee bids the smallest possible amount that assures its victory, but no more than $\frac{\overline{\pi}}{(1+\mu)(1+r)}$, after any bid that is strictly lower than $\frac{\overline{\pi}}{(1+\mu)(1+r)}$. It declines to bid otherwise. Note that this is a Nash equilibrium of the game. Since the incumbent franchisee will be challenged regardless of its choice of quality, its best reponse is to provide low quality service. However, this equilibrium is not subgame perfect. If the incumbent franchisee provides high quality service (and matches any bid up to $\frac{\underline{\pi}}{(1+\mu)r}$ if challenged), the next rival would be better off not bidding it since it will incur the cost of submitting a bid but because of the tie-breaking rule will lose.[26] But if the next rival firm declines to bid, providing high quality service is better than providing low quality

[26] Note that $\frac{\underline{\pi}}{(1+\mu)r}$ is the discounted sum of payoffs from continuing to provide high quality service forever, taking the cost of bidding into account.

service and the equilibrium unravels.

The next example demonstrates the importance of the assumption of anonymity, or that rival firms' strategies do not depend on the incumbent franchisee's identity.

Example 2 (The importance of Anonymity). Consider the following profile of strategies: The incumbent franchisee at time 1, i_1, provides low quality service as long as it remains the incumbent. Whenever challenged, it matches any bid that is smaller than the discounted sum of payoffs from continuing to provide low quality service, unchallenged, taking the cost of bidding into account, i.e., it matches any bid that is smaller than $\frac{\overline{\pi}}{(1+\mu)r}$, and declines to bid otherwise. The strategy of a rival firm that appears in any period $t \geq 1$ is to decline to challenge the incumbent franchisee if it is the first incumbent franchisee i_1, but when facing any other incumbent franchisee, to decline to bid if the incumbent franchisee provided high quality service, but to bid $\frac{\pi}{(1+\mu)r}$ if the incumbent franchisee provided low quality service. While it holds the license to operate the franchise, the rival firm always provides high quality service and matches any bid that is smaller or equal to $\frac{\pi}{(1+\mu)r}$. Along the equilibrium path, the first incumbent franchisee provides low quality service in every period and is never challenged. The reason for this is that future rival firms treat i_1 differently than they treat any other incumbent franchisee. They "allow" the first incumbent franchisee to provide low quality service but "demand" from any other franchisee to provide high quality service. Since the payoff to an incumbent franchisee that provides high quality service in every period is lower than the payoff to an incumbent franchisee that provides low quality service (and retains the franchise) forever, the first incumbent franchisee can never be defeated.

3.2. General Analysis

In this subsection we extend the analysis presented in the previous subsection to incorporate technological progress. Recall that the set of technologies available at any period $t \geq 1$ is given by $\{a_1, ..., a_t\}$, and that a firm with technological capability $a_k \in \{a_1, ..., a_t\}$ at t may invest an amount $c_t \geq 0$ to ensure that it will have a technological capability a_{k+1} in period $t+1$.

We modify RR1 as follows:

Regulator's Rule 1*. *The regulator sets the terms of the contract such that the payoff to the franchisee from providing low quality service for one period is lower or equal to*

the discounted sum of benefits associated with providing high quality service forever while incurring the cost of maintaining high technological capability in every period. Or, for every $t \geq 1$,

$$\sum_{\tau=1}^{\infty} \left(\frac{1}{1+r}\right)^{\tau} \left[\pi_{t+\tau}\left(a_{t+\tau}, q_H\right) - c_{t+\tau}\right] \geq \left(\frac{1}{1+r}\right) \pi_{t+1}\left(a_{t+1}, q_L\right). \qquad (**)$$

We emphasize the fact that RR1* can be as easily followed as RR1. As in the previous subsection, RR1* and RR2 ensure that providing high quality service and maintaining technological competitiveness is an equilibrium of the game. To ensure that this is the unique subgame perfect equilibrium of the game, we need to impose Assumptions 1 and 2 above, as well as the following monotonicity assumption.

Assumption 3 ("Rival firms' bids are monotone in the incumbent franchisee's technological capability"). *For every rival firm* j*, if* j *bids for the right to operate the franchise against an incumbent franchisee with technological capability* a^**, then after an identical history,* j *also bids against an incumbent franchisee with technological capability* $a < a^*$.

Assumption 3 can be motivated by considering the regulator's role in affecting the technological capability of challenging firms and the incentives that firms have to reveal their true technological capabilities. Suppose that rival firms' strategies are not monotone in the incumbent franchisee's technological capabilities. Future rival firms challenge technologically advanced franchisees but decline to challenge technologically inferior franchisees. Suppose further that as a consequence of this behavior, technologically superior firms decline to challenge the current incumbent franchisee. The regulator can overcome this difficulty by soliciting bids from technologically inferior firms (recall that by assumption, rival firms are always as technologically capable as the incumbent franchisee), or, a technologically superior firm can pretend to have a lower technological capability than it really has. For the sake of simplicity, we rely on Assumption 3 instead of considering a more general model where the regulator can affect rival firms' technological capabilities by soliciting bids from certain firms and not others, and franchisees can pretend to have a lower technological capability (but not a higher one). The next example demonstrates that unless such a more general model is considered, Assumption 3 is necessary for our results.

Example 3 (The importance of the monotonicity). The example is similar to Example

2. It considers a case where the incumbent franchisee's technological capability uniquely identifies it, thereby violating anonymity, in spite of the fact that firms cannot be identified by names. Suppose that technological progress stops after the first period. Firms then may have two technological capabilities, high $a_H = a_2$ and low $a_L = a_1$. Suppose further that except for the first incumbent franchisee who did not invest in technological improvement and has a low technological capability, all other firms have high technological capabilities. Since firms' strategies may depend on the incumbent franchisee's technological capability, the equilibrium profile of strategies described in Example 2 is a subgame perfect equilibrium here as well. Rival firm "allow" the first incumbent franchisee to provide low quality service, but "demand" from all other firms to provide high quality service. Thus, although it is technologically inferior, the first incumbent franchisee earns higher profits than other firms and is therefore never challenged.

We are now in a position to present our main result.

Theorem. *Suppose that the regulator follows RR1* and RR2, and Assumptions 1-3 are satisfied. Then, the game described above has a generically unique subgame perfect equilibrium. In this equilibrium, the incumbent franchisee always provides high quality service, and in every period invests in improving its technology. It is never challenged.*[27]

The strategies that support this equilibrium are similar to those that support the equilibrium described in the Proposition, the only difference being that in the equilibrium described in the Theorem, the incumbent franchisee invests in improving its technological capability in every period. The proofs of the two theorems are also similar. Lemma 3 in the appendix shows that Assumption 3 implies that technologically superior firms always defeat technologically inferior firms, and the rest of the proof relies on the same arguments as in the proof of the Proposition.

4. Discussion

4.1. Robustness with respect to Uncertainty

The fact that in the equilibrium we describe in the Theorem, the same incumbent franchisee retains the license forever hinges on the fact that we model technological progress as a de-

[27] The notion of genericity is identical to the one used in the statement of the Proposition (footnote 25).

terministic process. The basic model described in Section 2 can be expanded to incorporate uncertainty about the underlying environment, and hence also about the future terms of the franchise contract, about the technological capability of future rivals, and about the return to investment in improving the technological capability of the incumbent franchisee. We would need to further modify RR1*, but our main results would remain qualitatively unchanged. The incumbent franchisee would retain the license for a long period of time rather than forever, and providing low quality service would imply that the incumbent franchisee is very likely, as opposed to certain, to be challenged and replaced immediately thereafter. To support this new equilibrium, RR1* would have to be modified to incorporate the incumbent franchisee's expectations about future changes in the underlying environment and the terms of the franchise contract, and such that the following two conditions are satisfied: (1) as long as the incumbent franchisee continues to invest in technological improvement, the likelihood that a technologically superior rival firm appears remains small. This condition, which may be interpreted as implying the difficulty of achieving exceptional technological advancements, is required to ensure that the incumbent franchisee indeed retains the license for a long enough period of time. (2) The likelihood that at any point in time, the rival firm has a technological capability that is equal to that of the incumbent franchisee's is high. This second condition, which may be interpreted as implying considerable technological spillovers, is required in order to discipline the incumbent franchisee. Unless it is satisfied, incumbent franchisees may be tempted to try and capitalize on their technological advantage by providing low quality service.

4.2. Sunk Costs, the Transferability of Investment, and Asset Specificity

Williamson's (1976) main criticism of the "Chicago School approach" to franchise bidding concerns what he claimed was its facile dismissal of the related issues of sunk costs, the incentives to invest, the transferability of investment and asset specificity. The basic problem is as follows. Suppose that the incumbent franchisee has to incur a large irreversible cost in order to operate the franchise. This gives the incumbent franchisee a clear advantage over its rivals since in the bidding stage, potential rival firms have to consider their future per-period profits as well as the required irreversible costs, whereas the incumbent franchisee, for whom these costs are sunk, only has to consider its future per-period profits. This asymmetry between the incumbent and its rival may give rise to several types of inefficiencies: First,

incumbent franchisees may under-invest in capital equipment for fear they will not be able to recapture their investment when they are replaced. Second, the sunk costs may have to be incurred again and again as the incumbent franchisee is replaced which is socially wasteful. And third, the presence of sunk costs biases the bidding in favor of the incumbent franchisee who may outbid its rivals in spite of being less productively efficient and expecting lower profits.

Demsetz (1968) and Posner (1972) anticipated the first point by describing various ways according to which incumbent franchisees can be compensated for their capital investments, and the second point by remarking that incumbent franchisee's capital investments can be transferred from one incumbent franchisee to the next to minimize social inefficiency. However, Williamson (1976) pointed to the difficulties associated with these schemes especially when capital investments are highly specific.[28] He concluded that in those industries where assets are generally less specific such as local service airlines, postal delivery, and trucking, franchise bidding may be a satisfactory solution, but in other industries such as utility services (gas, water, electricity, telephone), direct regulation is likely to perform at least as well as franchise bidding.

An insight that can be gained from our approach is that along the equilibrium path, the incumbent franchisee may (efficiently) retain the license for long periods of time. Thus, the first two problems above need not imply great losses of social welfare.

Regarding the third problem above, it is possible to restore the bidding parity between the incumbent franchisee and rival firms by compensating firms for their capital investments. In many cases, the state is or can be the owner of all capital equipment. It is also important to emphasize that even if bidding parity is violated, then as long as this violation is not so large as to eliminate all effective competition and destroy the incumbent franchisee's incentives to provide high quality service, a sufficiently technologically superior rival may still outbid the incumbent franchisee. The idea of contestable licensing is robust to the presence of such transaction costs as long as they are not too large.

[28] Williamson (1976) also elaborated on the difficulties of correctly measuring capital invesments. These concerns pose less of a problem if firms are approximately risk neutral and the regulator observes an approximately unbiased signal about its capital investment.

5. Conclusion

The analysis presented here argues for the potential benefits of contestable licensing in natural monopoly environments where quality is observable but not verifiable. We should emphasize that our purpose is not to defend "markets" against "regulation," but rather to consider a possible reform of regulatory policy in a direction that calls for more competition and less direct involvement on part of the regulator. We certainly do not intend giving up regulation altogether. We hope that reframing the argument between the "Chicago approach" and Williamson (1976) in the context of a specific formal model helps clarify some of the basic ideas and suggests some directions for further research.

Appendix

Proof of the Proposition. We first describe the subgame perfect equilibrium and then prove it is generically unique. Recall that the statement "bid b" should be interpreted as "bid the highest integer multiple of m smaller or equal to b." Consider the following profile of strategies: The incumbent franchisee provides high quality service in every period. Whenever challenged, an incumbent franchisee that has always provided high quality service matches any bid that is equal or below the discounted sum of payoffs from providing high quality service taking the cost of bidding, or

$$\frac{1}{1+\mu}\sum_{\tau=1}^{\infty}\left(\frac{1}{1+r}\right)^{\tau}\pi_{t+\tau}\left(a_{t+\tau},q_H\right),$$

into account. In case a higher bid is submitted, the incumbent franchisee declines to bid. An incumbent franchisee that has provided low quality service in the last period responds to any challenge that is equal or below the highest integer multiple of m equal or below

$$\frac{1}{1+\mu}\sum_{\tau=1}^{\infty}\left(\frac{1}{1+r}\right)^{\tau}\pi_{t+\tau}\left(a_{t+\tau},q_H\right)-m$$

by bidding the smallest integer multiple of m above it, and declines to respond to higher bids. Rival firms' strategies are as follows. If the incumbent franchisee provided low quality service in any period t, then the rival firm that appears at the end of period t bids an amount that is equal to the discounted sum of payoffs from providing high quality service taking the cost of bidding into account. Rival firms decline to bid otherwise. Note that along the equilibrium path, incumbent franchisees always provide high quality service and are never challenged.

It is easy to verify that this is indeed a subgame perfect equilibrium. The tie breaking rule employed by the regulator implies that the incumbent franchisee is immediately replaced if it ever provides low quality service. RR1 implies that the incumbent franchisee is sufficiently forward looking to prefer the discounted sum of payoffs associated with continuing to provide high quality service to the payoff it could get by deviating and providing low quality service. It is straightforward to verify that rival firms' strategies are optimal as well.

The proof of uniqueness follows from the next two lemmas.

Lemma 1. *Generically, in every subgame perfect equilibrium, an incumbent franchisee is successfully challenged and replaced at the end of any period in which it provided low quality service.*

Proof. Fix a subgame perfect equilibrium (SPE). Suppose that at some period t, the incumbent franchisee, denoted i, provided low quality service. Denote the rival firm that appears at the end of the period by j. Denote the SPE discounted sum of payoffs the incumbent franchisee expects to get from period $t+1$ onwards if it succeeds in deterring or defeating the challenger in period t by π^i_{t+1}. Similarly, let π^j_{t+1} denote the SPE discounted sum of payoffs that the rival firm in period t expects to get from period $t+1$ onwards if it succeeds in winning the license. Note that since the incumbent franchisee in period $t+1$ can always provide low quality service in period $t+1$ and decline to respond to challenges thereafter, both $\pi^i_{t+1}, \pi^j_{t+1} > 0$.

We show that $\pi^j_{t+1} \geq \pi^i_{t+1}$. Note that in this case, since the regulator's tie-breaking rule favors the rival firm j, this implies that j can defeat the incumbent franchisee by bidding no more than the highest integer multiple of m smaller or equal to $\frac{1}{1+\mu}\pi^i_{t+1}$ and generically obtain a positive payoff. Therefore, if $\pi^j_{t+1} \geq \pi^i_{t+1}$, then j will successfully challenge and replace the incumbent franchisee i in the SPE.

We show that there is a strategy for j under which $\pi^j_{t+1} \geq \pi^i_{t+1}$. In a SPE, since bidding is costly, if a bid is submitted, then it is successful. We can therefore distinguish between the following two cases: (1) There exists some period $T \geq t$ where along the SPE path, i is outbidden and loses the franchise, and (2) i is never outbidden on the SPE path after and including period t.

Consider case (1) first. Since if $T = t$, then along the SPE path j outbids i at t, we may assume that $T > t$. Now, j knows that if it retains the license up to period $T-1$, then starting from period T onwards, it can expect a larger or equal future discounted sum of payoffs than i because it can provide the same quality service as i does in period T and it may retain the license after T as well. Therefore, if challenged at the end of period $T-1$, j would be willing to bid at least as much as i would in order to retain the license. By Assumption 1, the rival firm that appears in period $T-1$ expects a future discounted payoff that depends only on how it itself performs while it holds the franchise. In particular, it is indifferent between bidding against i or j. Consequently, the rival firm that appears in period $T-1$ will (successfully) outbid j only if it will also successfully outbid i. Therefore, it must be the case that $\pi^j_{T-1} \geq \pi^i_{T-1}$. Repeating the same argument for period $T-2$ implies that $\pi^j_{T-2} \geq \pi^i_{T-2}$. Repeating the same argument $T-t-3$ more times, implies that it must also be the case that $\pi^j_{t+1} \geq \pi^i_{t+1}$.

Consider now case (2). By assumption, i is not outbidden along the SPE path. In particular, on the SPE path, i holds the franchise in period $t+k+1$. Suppose now that j outbids i in period t and then adopts the same strategy that i uses from time $t+1$ onwards. If j survives unchallenged to period $t+k+1$, then since it adopted i's strategy, the players' bounded recall implies that j will be treated thereafter no worse than i would, and thus $\pi^j_{t+k+1} = \pi^i_{t+k+1}$. The backwards induction argument presented in case (1) above can be then re-applied to imply that $\pi^j_{t+1} = \pi^i_{t+1}$. Therefore, to complete the proof of the lemma, we must show that j will indeed not be challenged between periods $t+1$ and $t+k$. This too is shown by backwards induction. Consider period $t+k$, and suppose that j has not been challenged between periods $t+1$ and $t+k-1$. If j defeats the rival firm at $t+k$, then, because of the players' bounded recall, it can expect to be treated no worse than i would thereafter, and thus $\pi^j_{t+k+1} = \pi^i_{t+k+1}$. j would therefore be willing to bid as much as i would in order to defeat the rival firm at $t+k$. By Assumption 1, the rival firm that appears in period $t+k$ expects a future discounted payoff that depends only on how it itself performs while operating the franchise. In particular, it is indifferent between bidding against i or j. By assumption, on the SPE path, the rival firm at $t+k$ refrained from bidding against i, therefore, it must also refrain from bidding against j. But this implies that j and i expect the same future discounted payoff starting from period $t+k$, and thus $\pi^j_{t+k} = \pi^i_{t+k}$. Repeating the same argument $k-1$ more times implies that j would not be challenged anytime between periods $t+1$ and $t+k$. ■

Lemma 2. *Generically, in every subgame perfect equilibrium, an incumbent franchisee is not challenged (or replaced) at the end of a period in which it provided high quality service.*

Proof. The proof is similar to the proof of the previous lemma. Fix a subgame perfect equilibrium (SPE) and a time t. Recall the definitions of π^i_{t+1} and π^j_{t+1} from the proof of the previous lemma. Suppose that contrary to what is claimed, the incumbent franchisee i at t is successfully challenged and replaced by a rival firm j at the end of a period where it provided high quality service. By assumption, the incumbent franchisee at t is favored by the regulator's tie-breaking rule. Therefore the fact that i is successfully challenged implies that it must be the case that $\pi^j_{t+1} > \pi^i_{t+1}$. We show that this cannot be and obtain a contradiction. The proof is identical to the one given in the previous lemma with the roles of i and j reversed. ■

Proof of the Theorem. The proof is similar to the proof of the Theorem 1. We first describe the subgame perfect equilibrium and then prove that it is generically unique. Recall that the statement "bid b" should be interpreted as "bid the highest integer multiple of m smaller or equal to b." Consider the following profile of strategies: The incumbent franchisee provides high quality service in every period, and in every period, invests in maintaining its technological competitiveness. Whenever challenged, an incumbent franchisee that has always provided high quality service matches any bid that is equal or below the discounted sum of payoffs from providing high quality service taking the cost of bidding as well as the cost of maintaining technological competitiveness, or

$$\frac{1}{1+\mu}\sum_{\tau=1}^{\infty}\left(\frac{1}{1+r}\right)^{\tau}\left[\pi_{t+\tau}\left(a_{t+\tau},q_H\right)-c_{t+\tau}\right],$$

into account. In case a higher bid is submitted, the incumbent franchisee declines to bid. An incumbent franchisee that has provided low quality service in the last period responds to any challenge that is equal or below the highest integer multiple of m equal or below

$$\frac{1}{1+\mu}\sum_{\tau=1}^{\infty}\left(\frac{1}{1+r}\right)^{\tau}\left[\pi_{t+\tau}\left(a_{t+\tau},q_H\right)-c_{t+\tau}\right]-m$$

by bidding the smallest integer multiple of m above it, and declines to respond to higher bids. Rival firms' strategies are as follows. Rivals that have the same technological capability as the incumbent franchisee bid an amount that is equal to the discounted sum of payoffs from providing high quality service taking the cost of bidding as well as the cost of maintaining technological competitiveness into account if the incumbent provided low quality service, and decline to bid otherwise. Rivals with superior technologies bid m above that (and win the license in equilibrium). Along the equilibrium path, incumbent franchisees always provide high quality service and invest in improving their technological capability. They are never replaced.

It is easy to verify that this is indeed a subgame perfect equilibrium. If the incumbent franchisee ever provides low quality service, then a rival firm, that is at least as equally technologically advanced, bids for the license and wins since it is favored by the regulator's tie-breaking rule. If the incumbent franchisee ever fails to invest in improving its technological capability, then a technologically superior rival firm appears, outbids the incumbent and wins the license. RR1* implies that the incumbent franchisee is sufficiently forward looking to prefer the discounted sum of payoff associated with continuing to provide high quality

service and investing in improving its technological capability, to the payoff it could get by deviating and providing low quality service, or failing to invest in improving its technological capability.

The proof of uniqueness follows from the next lemma.

Lemma 3. *In every subgame perfect equilibrium, a firm that has superior technology always outbids a firm with inferior technology.*

Proof. Fix a subgame perfect equilibrium (SPE). Suppose that at some period t, an incumbent franchisee i with technology a faces a rival firm j with superior technology. As in the proof of Lemma 1, denote the SPE discounted payoff the incumbent franchisee i expects to get from period $t+1$ onwards if it succeeds in deterring or outbidding the rival firm j in period t by π^i_{t+1}. Similarly, let π^j_{t+1} denote the SPE discounted payoff that the challenger firm j expects to get from period $t+1$ onwards if it succeeds in outbidding the incumbent franchisee i and obtaining the license to operate the franchise. As before, note that since the incumbent franchisee in period $t+1$ can provide low quality service in period $t+1$ and decline to respond to challenges, both $\pi^i_{t+1}, \pi^j_{t+1} > 0$. We show that $\pi^j_{t+1} > \pi^i_{t+1}$. Note that this implies that j can defeat i by bidding no more than the highest integer multiple of m smaller or equal to $\frac{1}{1+\mu}\pi^i_{t+1} + m$, and still generically obtain a positive payoff. Therefore, if $\pi^j_{t+1} > \pi^i_{t+1}$, then j will successfully challenge and replace the incumbent franchisee i.

We show that there is a strategy for the rival firm j at t under which $\pi^j_{t+1} > \pi^i_{t+1}$. The proof is almost identical to the one given in Lemma 1 and is therefore not reproduced. The only differences between this proof and the one given before are that (1) here, because of j's technological superiority, we obtain strict as opposed to weak inequalities, and (2) here, we need to rely on Assumption 3 (monotonicity) instead of anonymity to guarantee that after a sufficiently long history, i and j will be treated equally by all future rival firms.

A similar argument applies when the challenger firm j is technologically inferior to the incumbent i. However, in this case, because of the cost of bidding, along the equilibrium path j would not bid for the license. This completes the proof of the lemma. ■

To complete the proof of the theorem, note that Lemmas 1 and 2 above still apply here with the qualification that only incumbents and rivals that have the same technological capability are considered. ■

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