Royalties and Flat Fees

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Consider a firm with two research and development projects. Suppose the firm must divest itself of one of the two projects by selling it to a competitor. This report discusses some of the issues that arise when one compares two methods of sale: an up-front flat fee and a royalty as a percentage of sales. Although royalty contracts have sometimes been asserted to facilitate collusion, there are reasons to believe that such fears are often exaggerated and that a divesting firm is likely to have other reasons for preferring royalty contracts.

To see that there are other reasons for royalty contracts than to facilitate collusion, consider an example where there is no benefit from collusion. Specifically, assume that the projects, if both are successful, result in products that are completely independent in the sense that the price of one has no impact on the demand for the other. Further assume that the post-invention behavior of the firms is independent of the form of the sales contract. Specifically, the value of the divested project—if it is undertaken—is given by the present value of revenues net of production costs and development costs, $R - C - I$, where R, C, and I are independent of the actions of the firms. These strict assumptions, relaxed below, rule out collusion as a motive for preferring royalties to flat fees; yet such a preference can still exist.

One possible source of this preference is that the divesting firm naturally knows more about the value of the project than does the acquiring firm. If both firms knew the value of the project, they would both be indifferent between a flat fee of ϕ and a royalty rate of r if $\phi = rR$.[1] However, suppose (to take an extreme example) the project either has a positive value, $R_V - C_V - I_V = V > 0$ or no value, $R_0 - C_0 - I_0 \leq 0$, that the divesting firm knows the truth, and that the acquiring firm is ignorant of the truth. Assume the divesting firm's information is not transferable to the acquiring firm: for example, a detailed inspection might allow the acquiring firm to imitate the project without closing the deal. So if the

[1] This is derived by noting that the acquiring firm's profit is $R-C-I-\phi$ from a flat fee and $(1-r)R-C-I$ from a royalty. Setting these expressions equal yields the result.

divesting firm has a valuable project, it must find another way to signal this information.

Consider a sequence of actions of the following form. The divesting firm offers a contract, which specifies either a flat fee or a royalty. The acquiring firm either accepts or rejects the contract. If the acquiring firm rejects the contract the game ends and both firms receive zero. If the acquiring firm accepts the contract it inspects the project and decides whether to proceed. If it proceeds, it enjoys the value of the project and pays the divesting firm either the flat fee or the royalty, as specified in the contract. If it does not proceed, it gains nothing from the project; if the contract calls for a flat fee the acquiring firm pays it whereas if the contract calls for a royalty the acquiring firm, having no sales, pays nothing.

Now suppose the acquiring firm believes there is a probability ρ that the project has the positive value V and a probability $(1-\rho)$ that the project has no value. Suppose only flat fee contracts are allowed. Then the acquiring firm is not willing to pay more than $\phi = \rho V$ for the project.[2] Of course, a divesting firm with a worthless project would be delighted with such an outcome, having received something for nothing at the expense of the acquiring firm; but a divesting firm with a worthwhile project fails to capture its value.

If royalty contracts are allowed, the result differs. A divesting firm with a high value project can now request any royalty $r \leq V/R_V$ (and thus receive royalty payments of up to the full value of the project). The acquiring firm can profitably accept such a contract. If the project is worthwhile, the acquiring firm will enjoy profits of

$$(1-r)R_V - C_V - I_V \geq (1 - V/R_V)R_V - C_V - I_V = 0.$$

If the project is not worthwhile, the acquiring firm can simply decline to develop it and avoid loss (since in that case no royalty is due). To summarize, a divesting firm with a worthwhile project may have an incentive to offer a royalty contract to signal its quality. This motivation has nothing to do with a desire to collude.

[2] Formally, there is no separating equilibrium—that is, no equilibrium where the fee depends on the value of the project—such that a positive-value project sells for a positive price. The reason is that there is nothing to keep a firm with a worthless project from charging the positive flat fee while claiming to have a high-value project. Thus the only equilibria exhibiting a sale at a positive price exhibit the same price for both types of projects. No information about the value of the project can be signalled by the price.

Another possible motivation for royalties arises when neither firm has a very good estimate of the project's value. This makes it difficult to set a flat fee. It is, however, relatively straightforward to bargain over a division of the profits. This suggests that a royalty on profits is to be preferred. However, profits are typically more difficult to define than sales (because, for example, overhead costs can be assigned in arbitrary ways to different lines of business within a company) so a royalty on sales may be more practical to implement than a royalty on profits while accomplishing a similar purpose. To summarize, firms may use a royalty agreement to solve the problem of how to value a highly uncertain asset. This motivation, like the previous one, has nothing to do with a desire to collude.

When there is scope for collusion—specifically, when the strict assumptions of the previous example are relaxed—it is probably still not practical to calculate the royalty rate that most facilitates it, suggesting that non-collusive motivations for royalties are still the predominant ones. Indeed, the meaning of "most facilitates collusion" may not be entirely clear. Specifically, to allow for collusion, suppose the two products (if successfully developed) are not independent; that is, the price of one affects the demand for the other. After the project is divested, the divesting firm (firm 1) chooses how much to invest in the development of its remaining project, say I_1, and the acquiring firm (firm 2) chooses how much to invest in its newly acquired project, say I_2. The probability of each firm's success, say $\rho_i(I_i)$ for firm i, depends on the level of its investment. The successful firm or firms decide on their output strategies, denoted q_i for firm i, which jointly determine the present value of their revenues and costs. Of course, given the time lag between divestiture and product development, as well as the uncertainty concerning the qualities of the product, it is difficult to predict what the market conditions (for example, input prices and demand for the product) will be when (and if) the product or products are developed. Let s be a list of random variables that completely describe the market conditions, and let $F(s)$ be their distribution function. Let $q_i(s, n, r)$ be the equilibrium output strategy of firm i when market conditions are s at the time of invention, n firms are successful, and r is the royalty rate.[3] Reinterpret I_i as the equilibrium level of firm i's development cost. Then under a royalty contract, firm 1 has an

[3]Thus q_i specifies the evolution of firm i's output as a function, for example, of the evolution of market conditions and the other firm's past output choices.

expected profit of

$$\rho_1(I_1)\rho_2(I_2)\int\left[\begin{array}{c} R_1^2(q_1(s,2,r),q_2(s,2,r),s)-C_1(q_1(s,2,r),s) \\ -I_1+rR_2^2(q_1(s,2,r),q_2(s,2,r),s)\end{array}\right]dF(s) \tag{1a}$$

$$+\rho_1(I_1)\left[1-\rho_2(I_2)\right]\int\left[R_1^1(q_1(s,1,r),s)-C_1(q_1(s,1,r),s)-I_1\right]dF(s) \tag{1b}$$

$$+\left[1-\rho_1(I_1)\right]\rho_2(I_2)\int\left[-I_1+rR_2^1(q_2(s,1,r),s)\right]dF(s) \tag{1c}$$

$$+\left[1-\rho_1(I_1)\right]\left[1-\rho_2(I_2)\right](-I_1) \tag{1d}$$

where R_i^n is the present value of firm i's revenue when n firms successfully develop a product. This expected profit is the sum of four parts, labelled (1a)-(1d). There is only scope for collusion in the case that both firms develop a product, which occurs with probability $\rho_1(I_1)\rho_2(I_2)$ and is associated with (1a).[4] Since r is negotiated before the market conditions s are known, and is independent of s, it is unlikely to facilitate collusion maximally for every realization of s. Furthermore, standard models suggest that the level of sustainable collusion depends on a comparison by all firms of current gains to be had by deviating from collusion relative to the discounted future losses suffered due to the breakdown of collusion.[5] Thus choosing r to maximize collusive possibilities even "on average" (in the sense of maximizing the value of part (1a)) requires detailed knowledge of the functions R_1^2,R_2^2, C_1, C_2 and F. Even if such detailed information were available, which is implausible, maximization of the value of part (1a) may be inconsistent with overall expected profit maximization, since it ignores the effect of r on part (1c) of expected profit. Of course, the choice of r also requires the agreement of firm 2, further complicating the problem; firm 2 might prefer a larger share of lower profits. Finally, the best-laid plan to facilitate collusion could easily be undone by the obsolescence of the product or increased competition due to innovation by other firms. These considerations suggest that royalty contracts are a very unreliable way to facilitate collusion in this context, given the difficulty of predicting the future or even of knowing

[4]Note that if success is difficult to achieve, then $\rho_1\rho_2$ is low and the simultaneous development of two products is unlikely. Since collusion is only an issue when there are two products, it is an inconsequential problem in this case. By contrast, if success is easily obtained, then $\rho_1\rho_2$ is high. But then other firms are likely to also be successful in the development of substitute goods, making collusion more difficult.

[5]See, for example, Jean Tirole, 1988, *The Theory of Industrial Organization*, MIT Press, Chapter 6.

everything that is relevant about the present.

By contrast, non-collusive motivations for royalties over flat fees are compelling precisely because royalty arrangements address these difficulties. The acquiring firm can buy with confidence, knowing that if the project is of low value then royalties will be low or non-existent. As a result, the seller of a worthwhile project receives more attractive compensation. This motivation for royalties is simple and plausible, and the determination of the royalty rate is the result of straightforward negotiation over the division of the revenues. In short, the royalty mechanism is well-suited for a world where it is difficult to predict the future and where information is difficult to credibly convey.