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APPENDIX

Endogenous matching approach

In addition with the respondable risk approach, we develop in this online appendix a complementary explanation regarding the trade-off between risk and royalties in franchise contracting based on the *endogenous matching approach* (Serfes 2005 [4]).

The main argument is that uncertainty is correlated with the degree of risk aversion due to the endogenous matching between the franchisor's risk characteristics and franchisees' degree of risk aversion. Indeed, we demonstrate with a simple theoretical model that franchisees with lower degrees of risk aversion are matched with higher risk franchisors, and vice versa.

The implication of this theoretical result is that a negative relationship may occur between risk and royalties. Less risk adverse franchisees characterized by a strong entrepreneurial orientation select riskier outlets as well as contracts with higher-powered incentives - lower royalty rates - (e.g. Ackerberg and Botticini, 2002 [1] ; Prasad and Salmon, 2013 [3]). This result challenges the positive relationship predicted by the standard principal-agent model.

According to Serfes (2005) [4], a "Negative Assortative Matching" (NAM) defines a situation where agents with higher degrees of risk aversion are matched with lower risk principals, and vice versa. We adapt this framework to the case of franchise contracting. As incentive mechanism, we use the optimal solution for the royalty rate defined by Blair and Lafontaine (2005) in a one-sided moral hazard problem between a risk averse agent (the franchisee) and a risk neutral principal (the franchisor). We develop a simple model of contracting regarding a single franchisor-franchisee pair. Doing so, we provide a theoretical explanation regarding a trade-off between risk and royalties in franchise contracting. Our model results in the following proposition:

Proposition 0.1. *With NAM (i.e. when the profit function is sub-modular), the equilibrium is given by:*

(i) Positive if $\theta_L^2 < \frac{\theta_H^2 \rho_H}{2\rho_H - \rho_L}$

(ii) Negative if $\rho_H > 2\rho_L$ *and* $\theta_H^2 < \frac{\theta_L^2 \rho_L}{2\rho_L - \rho_H}$

(iii) U-shaped if one of the two conditions are satisfied

(a) $\rho_H < \rho_L$, $\theta_H^2 < \frac{\theta_L^2 \rho_L}{2\rho_L - \rho_H}$ *and* $\theta_L^2 < \frac{\theta_H^2 \rho_H}{2\rho_H - \rho_L}$

(b) $\rho_H < \rho_L$ *and* $\theta_L^2 < \frac{\theta_H^2 \rho_H}{2\rho_H - \rho_L}$

where, θ^2 *is the variance of sales* $[\theta_L^2, \theta_H^2]$, α *is the importance of the franchisee effort, and* (ρ) *the franchisee risk aversion* $[\rho_L, \rho_H]$.

Thus, in case of NAM, a negative relationship may occur between risk and royalties.

Proof

Incentive contract

Blair and Lafontaine (2005 [2]) demonstrated that given the franchisee risk aversion (ρ) and unobservable effort (e), equation (0.1) provides the best level of effort that the franchisor can achieve, even if it is lower than the first-best level (incentive constraint). The effort depends on the royalty rate (r) and on the importance of the effort (α).

$$e = (1 - r)\alpha \tag{0.1}$$

Then they show that in this case the best linear contract from a franchisor's perspective is given by the equation 0.2, since it provides a balance between the need to motivate franchisee effort and the need to provide insurance to the franchisees.

Therefore, the incentive royalty rate (r) depends on the importance of the franchisee effort (α), the franchisee risk aversion (ρ), and the variance of sales (θ).

$$r = \frac{\rho\theta^2}{\alpha^2 + \rho\theta^2} \tag{0.2}$$

In this case, when (θ) increases,(r^*) tends to 1 and when (θ) decreases tends to 0. It gives as already an intuition that depending on the variance of sales (incertitude), royalty can take different values.

Efficient matching

We focus on monotone assortative matching; in order to have a "Negative Assortative Matching" (NAM) defines a situation where agents with higher degrees of risk aversion are matched with lower risk principals, and vice versa (Serfes, 2005) [4].

We introduce equation (0.2) and (0.1) in the franchisor's expected profit $\Pi = r\alpha e + F$, where F is the upfront fee.

$$\Pi = \frac{\rho\theta^2\alpha^4}{(\alpha^2 + \rho\theta^2)^2} + F \tag{0.3}$$

The cross partial derivative is:

$$\frac{\partial\Pi}{\partial\rho\partial\theta^2} = 2\frac{\alpha^4}{(\alpha^2 + \rho\theta^2)^5}(-3\rho^3\theta^6 + 25\rho^2\theta^4\alpha^2 - 19\rho\theta^2\alpha^4 + \alpha^6) \tag{0.4}$$

The derivative in equation (0.4) can be positive and negative (see equation (0.5)).

$$-3\rho^3\theta^6 + 25\rho^2\theta^4\alpha^2 - 19\rho\theta^2\alpha^4 + \alpha^6 = 0 \tag{0.5}$$

According to Becker 1973 (in Serfes, 2005 [4]), there exists a negative assortative matching (agents with higher degrees of risk aversion are matched with lower risk principals and vice versa) when equation (0.4) is negative, since the profit function is submodular.

Risk-incentives equilibrium

As each principal should be matched with exactly one agent and vice versa, we assume that the equilibrium between risk and incentives is given by:

$$\int_{\theta_L^2}^{\theta_H^2} \frac{1}{\theta_H^2 - \theta_L^2} dx = \int_{\rho_L}^{\rho_H} \frac{1}{\rho_H - \rho_L} dy \tag{0.6}$$

Equation 0.6 provides a matching function, which is an equilibrium relationship between risk aversion and variance.

$$\frac{1}{\theta_H^2 - \theta_L^2} x|_{\theta_L^2}^{\theta_H^2} = \frac{1}{\rho_H - \rho_L} y|_{\rho_L}^{\rho_H}$$

$$\frac{\theta^2 - \theta_L^2}{\theta_H^2 - \theta_L^2} = \frac{\rho_H - \rho}{\rho_H - \rho_L}$$

$$\rho(\theta^2) = \frac{\theta^2(\rho_H - \rho_L)}{\theta^2 - \theta_L^2} + \frac{\theta_H^2 \rho_H - \theta_L^2 \rho_L}{\theta_H^2 - \theta_L^2} \tag{0.7}$$

Substituting equation (0.7) in (0.2), and differentiating to θ^2, we obtain:

$$\frac{d_r}{\theta^2} = \frac{\alpha^2(\theta_H^2 - \theta_L^2)[\rho_H \theta_H^2 - \rho_L \theta_L^2 - 2\theta^2(\rho_H - \rho_L)]}{[\alpha^2(\theta_H^2 - \theta_L^2) + \theta^2(\rho_H \theta_H^2 - \rho_L \theta_L^2) - \theta^4(\rho_H - \rho_L)]^2} \tag{0.8}$$

It is verified that $\frac{d_r}{\theta^2} > 0$ if, and only if, $\theta^2 < \lambda = \frac{\rho_H \theta_H^2 - \rho_L \theta_L^2}{2(\rho_H - \rho_L)}$. The conditions to have λ in $[\theta_L^2, \theta_H^2]$ are: (i) $\lambda < \theta_H^2$ if, and only if, $\rho_H > 2\rho_L$, (ii) $\lambda < \theta_H^2$ if, and only if, $\rho_H > 2\rho_L$ and $\theta_H^2 < \frac{\theta_L^2 \rho_L}{2\rho_L - \rho_H}$, and (iii) $\lambda > \theta_H^2$ if, and only if, $\theta_L^2 < \frac{\theta_H^2 \rho_H}{2\rho_H - \rho_L}$.

References

[1] D. A. Ackerberg and Botticini. Endogenous matching and the empirical determinants of contract form. *Journal of Political Economy*, 110:564–591, 2002.

[2] R. Blair and F. Lafontaine. *The Economics of Franchising.* Cambridge UniversityPress, first edition, 2005.

[3] K. Prasad and T. C. Salmon. Self selection and market power in risk sharing contracts. *Journal of Economic Behavior and Organization*, 90:71–86, 2013.

[4] K. Serfes. Risk sharing vs. incentives: Contract design under two-sided heterogeneity. *Economics Letters*, 88:343–349, 2005.