Silent Financial Interests and Product Innovation[*]

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Abstract

We study quality-enhancing R&D, price competition, and welfare in markets with asymmetric passive partial ownership (PPO) holdings. The asymmetries in PPOs generate a positive re-allocation effect which, in some cases, can increase consumer and total surplus in markets with no spillovers.

Keywords: partial ownership, minority shareholdings, R&D investments, price competition, welfare

JEL codes: D43, L11, L40, G24, G34.

1 Introduction

There has been a recent and significant surge in silent financial interests, also called passive partial ownership holdings (hereafter PPO) in rival firms held by common investors which has attracted the attention of competition authorities around the world.[1] Although it has been both theoretically and empirically documented that PPOs tend to reduce price competition (see, e.g., Bresnahan and Salop 1986, Reynolds and Snapp 1986, and Azar at al. 2017), there is limited research on the effects of PPOs in markets where firms also compete in investments. In this note we consider quality-enhancing R&D investments.

The asymmetries between firms are an important characteristic of these partial acquisitions because typically the PPOs are unequal across the industry. Recent examples include venture capital investors that acquire small stakes in competing firms often in high-technology sectors (see Hochberg et al., 2015).

Our main result is that asymmetric PPOs can increase total welfare and consumer surplus even without spillovers, although the region where the latter increases is limited. We identify a positive re-allocation effect: PPOs alter the R&D investments of the competing firms so that more consumers buy the good of higher quality, and as a result, aggregate utility increases. We discuss how the re-allocation effect relates to the vertical to horizontal differentiation ratio, and

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[1]For example, from 1900 to 1945 institutional investors owned close to 5% of the US stock market, while by 2010 this percentage had increased to almost 70% (Blume and Keim, 2014).

compare equilibrium prices, R&D expenditures and market shares under different ownership structures.

While the debate on the relationship between competition and innovation is old, the effects of (partial and full) acquisitions on innovation have only been recently begun to be explored. López and Vives (2017) show in a symmetric model that PPO may stimulate cost-reducing R&D investments and improve total surplus, and even increase consumer surplus but only if spillovers are sufficiently high. Motta and Tarantino (2017) study how mergers affect the incentives to invest in cost-reducing R&D and show that with no (or low) efficiency gains, mergers lower R&D expenditures and consumer surplus. Federico et al. (2017, 2018) consider an oligopoly model of probabilistic product innovation and also find that a merger reduces overall industry innovation. In contrast, in a model with price competition and quality-enhancing R&D investments, we find conditions such that asymmetric PPOs might be beneficial for both consumers and the economy.

Our analysis follows. The Appendix contains the proof of our main result (Proposition 3), and further proofs and simulations are provided in an Online Appendix.

2 Model

We consider a two period model with two firms (1 and 2 indexed by i, j, with $i \neq j$) and two investors. Each firm is owned by a major shareholder that controls the firm, but it might also be partially owned by another investor with a minority stake.[2] Let ω_i denote the stake in firm j of the major shareholder in firm i.[3] The manager of firm i maximizes the major shareholder's portfolio

$$\Pi_i = (1 - \omega_j)\pi_i + \omega_i \pi_j. \tag{1}$$

In the first period, the manager chooses a level of R&D, x_i, that increases product quality. In the second period, and for given x_i, the manager sets the price, p_i. Firm i's operating profit is

$$\pi_i = p_i s_i - \frac{\lambda}{2} x_i^2, \tag{2}$$

where s_i is firm i's market share, and $\lambda > 0$.

The market is characterized by a general ownership structure, (ω_i, ω_j), which allows for asymmetries arising from unequal PPOs between rival firms. Define $\Omega \equiv \omega_i + \omega_j$. We solve the model for the general ownership structure, and also discuss three cases of special interest: (a) the major shareholder of firm i has a stake ω_i in firm j, while the major shareholder of j does not have any stake in i, that is $(\omega_i, 0)$; (b) PPO interests are symmetric, $\omega_i = \omega_j = \omega$, thus (ω, ω); (c) a market with no PPO, then $(0, 0)$.

There is a continuum of consumers of mass 1 that is uniformly distributed along the unit line; consumers can purchase one unit of a good either from i or j. We assume full participation. A consumer located at $q \in [0, 1]$ that buys from firm i obtains utility $U_i(x_0, x_i) - t|q_i - q| - p$,

[2] This case is also known as common ownership. This is different from cross-ownership by firms, where firms acquire stakes in other firms.

[3] There is not a commonly agreed threshold for what constitutes non-controlling minority shareholdings by competitors. However, competition authorities often inspect the non-controlling minority shareholdings by competitors that are between 15% and 25% (Salop and O'Brien 2000). In some applications, we restrict that PPO satisfies $0 \leq \omega_i, \omega_j < 1/2$.

where $t > 0$ is the product differentiation parameter, $q_i \in \{0, 1\}$ is the location of the firm (without loss of generality: $q_i = 0, q_j = 1$), and U_i is given by

$$U_i(x_0, x_i) = x_0 + \rho x_i, \tag{3}$$

where x_0 is the initial gross utility and U_i strictly increases with x_i: $\rho > 0$. Define the vertical to horizontal differentiation ratio ($r \equiv \rho^2/t$): the smaller the ratio, the more important horizontal to vertical differentiation is. The market share of firm i, s_i, is

$$s_i = \frac{1}{2t}\left[\rho(x_i - x_j) + (p_j - p_i) + t\right],$$

and for firm j is $s_j = 1 - s_i$.

3 Equilibrium and market characterization

We solve the model for the general ownership structure and provide expressions for equilibrium R&D, prices and market shares in Lemma 1 in the Appendix. By comparing equilibrium outcomes between firms, we can establish that:

PROPOSITION 1 *(Inter-firm comparison) Let $\omega_i > \omega_j$, then firm i invests less in R&D than firm j. If the relative impact of quality on utility is sufficiently low such that $r < \bar{r} \equiv \frac{\lambda(3-\Omega)}{(4-\Omega)}$, then firm i competes less intensively than firm j in prices, otherwise, firm i becomes more competitive. Firm i's market share is lower than that of firm j.*

Consider first the ownership structure $\omega_i > \omega_j = 0$. Because firm j's profit positively affects the financial profit of the major shareholder in firm i, the manager of the latter has lower incentives to compete for market share. Thus, firm i decreases its R&D investment and charges a higher price than j. However, when the relative importance of vertical differentiation is sufficiently high (or the investment cost is sufficiently low), firm i may set a lower price than firm j in order to avoid losing too much market share. Note that at the second stage, the loss in quality of firm i's good is exacerbated by the gain in quality of firm j's (since R&D investments are strategic substitutes). The same reasoning applies to the more general case $\omega_i > \omega_j > 0$. The threshold $\bar{r}$ decreases with ω_i (and with ω_j) because the incentives for i to compete are lower as firm j's profit becomes relatively more important to the manager of firm i.[4]

[4] Note that maximizing $\Pi_i = (1 - \omega_j)\pi_i + \omega_i \pi_j$ is equivalent to maximizing $\pi_i + \vartheta_i \pi_j$, where $\vartheta_i \equiv \frac{\omega_i}{1-\omega_j}$ is the relative weight of firm j in the objective function of the manager in firm i, and ϑ_i is increasing in both ω_i and ω_j.

Next, we compare the equilibrium outcomes of each firm with and without partial ownership.

PROPOSITION 2 *(Intra-firm comparison) As compared to the case of no partial ownership:*

- *If $\omega_i = \omega_j = \omega > 0$, then firms compete less aggressively in R&D and prices.*
- *If $\omega_i > \omega_j = 0$, then firm i competes less aggressively in R&D, and likewise in prices unless $r > 2\lambda$. In contrast, firm j competes more aggressively in R&D and less aggressively in prices; as a result, firm i's market share is smaller and firm j's market share is larger.*
- *If $\omega_i > \omega_j > 0$, then firm i always invests less in R&D, and charges a higher price unless $1/r < \theta_{p,i}(\omega_i, \omega_j)/\lambda$. Firm j always competes less aggressively in prices, and invests less (more) in R&D if $r < (>) \lambda\theta_{x,j}(\omega_i, \omega_j)$. As a result, firm i's market share is smaller, while that of firm j is larger. The expressions $\theta_{p,i}(\omega_i, \omega_j)$ and $\theta_{x,j}(\omega_i, \omega_j)$ are given in the Appendix.*

The first case describes a market with no asymmetry in PPO ($\omega_i = \omega_j = \omega > 0$). A higher ω in each firm induces them to compete less because managers maximize the financial profit of the major shareholder of each firm and therefore partially internalize the rival's profit.

The second case summarizes a particular asymmetric ownership structure ($\omega_i > \omega_j = 0$). Since firm j is partially owned by the major shareholder in firm i, the latter competes less aggressively in R&D, and also in prices except if the vertical to horizontal differentiation ratio is large or if the cost of investment is small (i.e. $r > 2\lambda$). The lower firm i's investment in R&D is accompanied by a higher investment of firm j (since investments are strategic substitutes). In the second stage, this translates into a significant loss of market share for i which firm i mitigates by offering a better price. Firm j, however, charges higher prices to extract the additional utility from its higher quality product.

The third case represents a general asymmetric ownership structure ($\omega_i > \omega_j > 0$). If quality is relatively insignificant (r is small enough) or the cost of investment is sufficiently great (λ is high enough) then both firms charge higher prices, and firm i makes a lower innovation effort. For a given ω_j, if ω_i is large enough, then firm j invests more in R&D than without partial ownership (as in the second case), while if ω_i is low enough then firm j invests less in R&D (as in the first case). Similarly, if r/λ is sufficiently large, then firm i may charge lower prices than in the case of no PPO in order to retain its customer base and to ameliorate the negative impact of the relatively low R&D investment on its market share (as in the second case). Overall, firm j (firm i) has a higher (lower) market share compared to markets with no partial ownership, where each firm splits the market equally. Notice that the equilibrium outcomes of the general asymmetric ownership structure have features of each of the two special cases being considered.

4 Welfare analysis

For a given ownership structure, consumer surplus is

$$CS = x_0 + \rho\left(x_i s_i + x_j s_j\right) - \frac{t}{2}\left(s_i^2 + s_j^2\right) - \left(p_i s_i + p_j s_j\right), \tag{4}$$

which is the sum of consumers' utility from buying from either of the firms minus the total payment transferred to each firm and the total cost due to product differentiation. Total surplus is $TS = CS + PS$, and thus equals

$$TS = x_0 + \rho (x_i s_i + x_j s_j) - \frac{t}{2}\left(s_i^2 + s_j^2\right) - \frac{\lambda}{2}\left(x_i^2 + x_j^2\right). \quad (5)$$

4.1 Welfare at the equilibrium allocation

In the next proposition, we compare total and consumer surplus with and without PPO for the two specific ownership structures.

PROPOSITION 3 *As compared to the case of no partial ownership:*

- *If $\omega_i = \omega_j = \omega > 0$, then consumer surplus and total surplus are lower with PPO.*
- *If $\omega_i > \omega_j = 0$, then consumer and total surplus might be lower or higher with PPO than with no PPO. For given t, λ, such that $\omega_i < 0.494$ ($\omega_i < 0.158$), there exists a ρ sufficiently large such that total surplus (consumer surplus) is higher with PPO than with no PPO.*

With a symmetric ownership structure, consumer surplus falls because of higher prices and the lower investment in R&D that leads to a lower aggregate utility. Total surplus is lower than with no PPO because the under-investment in R&D causes a large decrease in aggregate utility which is not compensated by the total cost-savings in R&D expenditures. This result is similar to that found by Federico et al. (2018), and related although more indirectly to that of López and Vives (2017) and Motta and Tarantino (2017).

The second case refers to the specific asymmetric ownership structure $\omega_i > \omega_j = 0$, and states that total surplus and consumer surplus with asymmetric PPO can be larger with partial ownership than without it. This occurs when the vertical to horizontal differentiation ratio is relatively important in relation to the cost of investments (r/λ is sufficiently large). With PPO, firm i reduces its innovation effort and also its market share, but firm j increases them both. This leads to an increase in aggregate utility due to a higher proportion of consumers buying the good of higher quality, which results in a positive *re-allocation effect*. If r/λ is large enough then the re-allocation effect may outweigh the total cost of investments, leading to a higher total surplus than with no PPO. Furthermore, if the increase in aggregate utility generated by the re-allocation effect exceeds the average price paid by consumers, then consumers surplus is higher with PPO than with no PPO. Simulations show that consumer surplus is larger with partial ownership than without it in a small region of parameters (in terms of t, λ, ρ and for some given ω_i). This is illustrated in Figures 1 and 2 in the Online Appendix D, where we show some parameter values with which these situations arise. Otherwise, total surplus and consumer surplus are lower with asymmetric PPO than with no PPO.

For the general ownership structure, we find that consumer surplus and total surplus might be higher with PPO than with no PPO if r/λ is sufficiently large, as in the case with $\omega_i > \omega_j = 0$. This is illustrated in the simulations of Figures 3-5 in Online Appendix D.

5 Concluding Remarks

This paper has studied how asymmetries in ownership holdings affect R&D investments, prices, competition, and welfare. In contrast to previous findings, we show that PPOs can increase total surplus and consumer surplus in markets with competition in prices and quality-enhancing R&D with no spillovers. This is a result of the asymmetries: in relation to when there are no financial links, the firm which is owned in a higher proportion by the major shareholder of the rival over-invests in R&D if the vertical to horizontal differentiation ratio is sufficiently large, the cost of R&D is sufficiently small, and the stake in one firm is sufficiently large in relation to the other. This leads to a positive *re-allocation effect*, which means that a larger proportion of consumers buy a good of higher quality, thus generating greater aggregate utility. Consequently, with PPO consumer surplus and welfare may be larger than without PPO.

This paper is the first step in a broader research agenda. Future work could examine product innovation with active partial ownership stakes, oligopolies, and market expansion.

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6 Appendix

Expressions for $\theta_{x,i}$ and $\theta_{p,i}$. In proof of Proposition 2 in Online Appendix C we show that

$$\theta_{x,i}(\omega_i,\omega_j) \equiv (3-\Omega)\,\frac{\omega_i\,(9-2\omega_i-\omega_j)-\omega_j(6-\omega_j)}{\Omega}$$

and

$$\theta_{p,i}(\omega_i,\omega_j) \equiv \frac{\omega_i\,(1-\omega_i)\,(3-\omega_i)+\omega_i\omega_j\,(3-\omega_j)-\omega_j\,(1-\omega_j)}{(3-\Omega)\,[2\omega_i(1-\omega_i)+\omega_j(1-\omega_j)+\omega_i\omega_j]}.$$

Lemma 1. *Assuming that $\frac{r}{\lambda}<\frac{(3-\Omega)^2}{2}$, so that the second-order condition and the stability condition are satisfied, for each firm $i,j=1,2$ such that $i\neq j$, at the (interior) equilibrium*

$$x_i^*(\omega_i;\omega_j) = \rho\frac{t\lambda\,(3-5\omega_i+\omega_i\Omega)\,(3-\Omega)-\rho^2\,(2-\Omega)}{\lambda\,(3-\Omega)\left[t\lambda\,(3-\Omega)^2-2\rho^2\right]},$$

$$p_i^*(\omega_i;\omega_j) = t\,(1-\omega_i)\,\frac{t\lambda\,(3-\Omega)\,(3+\omega_i-3\omega_j)-\rho^2\left[3(\omega_i-\omega_j)-\omega_i^2+\omega_j^2+2\right]}{\left[t\lambda\,(3-\Omega)^2-2\rho^2\right](1-\Omega)},$$

$$s_i^*(\omega_i;\omega_j) = \frac{t\lambda\,(3-2\omega_i)\,(3-\Omega)-\rho^2\,(2+\omega_i-\omega_j)}{2\left[t\lambda\,(3-\Omega)^2-2\rho^2\right]}.$$

Assuming that $\omega_i>\omega_j$, the interior equilibrium requires that $\frac{r}{\lambda}<\frac{(3-5\omega_i+\omega_i\Omega)(3-\Omega)}{(2-\Omega)}$.

Proof. See Online Appendix A.

Proof of Proposition 3. Denote TS^* and CS^* as the total and consumer surplus evaluated at the equilibrium allocation, respectively. (i) Evaluating TS^* and CS^* and comparing the two ownership structures, we obtain:

$$TS^*(\omega;\omega)-TS^*(0;0) = -\frac{\omega\rho^2(3-\omega)}{9\lambda\,(2\omega-3)^2}<0, \tag{6}$$

$$CS^*(\omega;\omega)-CS^*(0;0) = -\omega\frac{\left[3t\lambda\,(3-2\omega)+\rho^2\,(1-2\omega)\right]}{3\lambda\,(1-2\omega)\,(3-2\omega)}<0. \tag{7}$$

(ii) For the $(\omega_i,0)$ ownership structure, we obtain:

$$\begin{aligned}&TS^*(\omega_i;0)-TS^*(0;0) = \\ &\frac{\omega_i}{36\lambda\,(3-\omega_i)^2\,[t\lambda(3-\omega_i)^2-2\rho^2]^2}\Big[-4\rho^6\,(6-\omega_i)-t\lambda\rho^4\left(18\omega_i^2-77\omega_i-24\right)(\omega_i-3)^2 \\ &+2t^2\lambda^2\rho^2\left(5\omega_i^3-24\omega_i^2+18\omega_i-27\right)(3-\omega_i)^2-9t^3\lambda^3\omega_i\,(3-\omega_i)^4\Big].\end{aligned}$$

Hence, the sign of total surplus in relation to markets with no PPO is:

$$sign\,\{TS^*(\omega_i;0)-TS^*(0;0)\} = sign\{\upsilon\rho^6+\varpi\rho^4+\mu\rho^2+\gamma\},$$

where $\upsilon\equiv-4\,(6-\omega_i)$, $\varpi\equiv-t\lambda\left(18\omega_i^2-77\omega_i-24\right)(3-\omega_i)^2$, $\gamma\equiv-9t^3\lambda^3\omega_i(3-\omega_i)^4$, and $\mu\equiv2t^2\lambda^2\left(5\omega_i^3-24\omega_i^2+18\omega_i-27\right)(3-\omega_i)^2$. For $0\leq\omega_i<1/2$: $\upsilon<0$, $\varpi>0$, $\gamma\leq0$ and

$\mu < 0$. We find that when $\rho^2 \to 0$ then $TS^*(\omega_i;0) - TS^*(0;0) < 0$. Letting $\omega_i > \omega_j$, when ρ^2 takes the largest possible value, $\rho^2 \to \left(\frac{(3-\omega_i)(\omega_i^2-5\omega_i+3)\lambda t}{(2-\omega_i)}\right)$, then $TS^*(\omega_i;0) - TS^*(0;0) > 0$, provided that $\omega_i < 0.494$. Hence, for given t, λ, such that $\omega_i < 0.494$, there must exist a high enough ρ^2 such that $TS^*(\omega_i;0) - TS^*(0;0) > 0$.

With regards to consumer surplus we find that:

$$CS^*(\omega_i;0) - CS^*(0;0) =$$
$$\omega_i \frac{-8\rho^6 + 7t\lambda\omega_i\rho^4 (3-\omega_i) + 2t^2\lambda^2\rho^2 \left(2\omega_i^2 - 6\omega_i + 27\right)(3-\omega_i)^2 - 3t^3\lambda^3 (18-7\omega_i)(3-\omega_i)^3}{12\lambda (3-\omega_i) \left[t\lambda(3-\omega_i)^2 - 2\rho^2\right]^2}.$$

Hence, the sign of consumer surplus in relation to markets with no PPO is:

$$sign\left\{CS^*(\omega_i;0) - CS^*(0;0)\right\} = sign\{-8\rho^6 + \beta\rho^4 + \delta\rho^2 + \epsilon\},$$

where $\beta \equiv 7t\lambda\omega_i (3-\omega_i)$, $\delta \equiv 2t^2\lambda^2 \left(2\omega_i^2 - 6\omega_i + 27\right)(3-\omega_i)^2$, and $\epsilon \equiv -3t^3\lambda^3 (18-7\omega_i)(3-\omega_i)^3$. For $0 \leq \omega_i < 1/2$: $\beta \geq 0$, $\delta > 0$ and $\epsilon < 0$. We find that when $\rho^2 \to 0$ then $CS^*(\omega_i;0) - CS^*(0;0) < 0$, while when ρ^2 takes the largest possible value, $\rho^2 \to \left(\frac{(3-\omega_i)(\omega_i^2-5\omega_i+3)\lambda t}{(2-\omega_i)}\right)$, then $CS^*(\omega_i;0) - CS^*(0;0) > 0$ if $\omega_i < 0.158$. Hence, for given t, λ, such that $\omega_i < 0.158$, there must exist a sufficiently large ρ^2 such that $CS^*(\omega_i;0) - CS^*(0;0) > 0$. ■