Platform Components with Outside Opportunities

Christiaan Hogendorn

October 16, 2009

Rough draft: please do not cite or quote.

Abstract

Two-sided platforms coordinate two types of users in order to increase the value of the whole system surrounding the platform. Users of a platform have different outside opportunities, and these influence their behavior on the platform. Platforms often limit these outside projects through licensing agreements that contain exclusivity clauses. These are often thought to reflect market power and a foreclosure motivation, but we show here that they can be a way of managing the "quality commons" aspect of a platform. This paper analyzes a platform where all component developers produce two kinds of quality – inside quality for their offerings on the platform and outside quality on their outside project. It shows that there are cases where exclusive licensing agreements that shut down the outside projects can increase social welfare, while in other cases they reduce social welfare. The reason is that if consumers and the platform value components inside quality enough, all agents prefer to be protected from low-quality behavior, even at the cost of giving up outside projects.

1 Introduction

Two-sided platforms coordinate two types of users in order to increase the value of the whole system surrounding the platform. Platform researchers have also begun to study the complex roles that platforms take as "facilitators" or "regulators" of their associated component systems. In this paper, we focus on a related issue – users of a platform have different *outside opportunities*, and these influence their behavior on the platform.

One highly visible way that platforms may behave as "regulators" is to insert exclusivity clauses in their license agreements. These clauses specify that if a firm produces a component for a platform, then it may not engage in some other activity that would otherwise be profitable. The scope of exclusivity can range from a total ban on all other projects to limitations on how the platform technology can be used. For example, shopping malls often limit the radius in which a tenant can build another store. And information technology platforms often limit the uses of the platform technology to certain approved lines of development.

This paper focuses on an efficiency-based motivation for these exclusive clauses. Some component firms may have outside opportunities that conflict with the inside goals of the platform and the other components on the platform. Specifically, we consider a case where component firms have diseconomies of scope in developing high-quality components. Such diseconomies could arise because of scarce managerial attention, scarce creative talent, or scarce marketing resources. If the quality of platform components has spillovers to the platform as a whole, a situation we term a *quality commons*, then the platform may want to take steps to remove the diseconomies of scope via exclusivity clauses. While clearly beneficial to the platform, such clauses may or may not raise social welfare.

There are two other potential motivations for exclusivity clauses of the type we have mentioned. One is vertical foreclosure, which would typically involve the platform competing directly with the component provider with an integrated product. The other is demand-side network effects where one platform would attempt to tip the market, or at least dominate the market, by denying components to another platform. We do not suggest that either of these is implausible or even uncommon. Rather, we think that there are many additional cases where exclusivity clauses do not appear to serve either of these goals but are present in licensing agreements nonetheless. Journalistic accounts often refer to control over the "direction" or "focus" of the platform as motivation for such clauses. We think that is consistent with a quality commons approach.

The next section reviews some economics literature relevant to this paper. Section 3 presents a simple model of two types of component providers producing both inside projects on a platform and outside projects that may involve diseconomies of scope. In section 4 we analyze equilibrium with and without exclusivity clauses, and compare the social welfare. Section 5 concludes.

2 Literature

The timing of this model has the platform first announcing its contractual offerings to component providers and its pricing to consumers. Then the component providers choose whether or not to join the platform, and after observing the number of component providers, consumers decide to join the platform. This is is the sequential game structure pioneered in Katz and Shapiro (1985) and Church and Gandal (1992); both those papers showed that multiple equilibria are possible: there is always a zero equilibrium where the platform receives no components. Hagiu (2006) analyzed this timing in the context of two-sided pricing, paying particular attention to the question of whether the platform precommits to consumer pricing at stage 1 or chooses it *ex post* at stage 3. He finds that precommitment is optimal as long as sellers coordinate on the positive rather than zero equilibrium, an assumption that we follow here.

The sequential game structure is contrasted with simultaneous games where buyers and sellers join the platform at the same time. This structure was used in the original two-sided markets literature pioneered by Rochet and Tirole (2003) and Armstrong (2006).

This paper is part of the small but growing literature on the *quality* of members of platforms and the policies platforms adopt to enhance that quality. Boudreau and Hagiu (2008) introduce the idea that the platform is similar to a regulator, and may try to regulate quality. Damiano and Hao (2008) study platform pricing as an aid to platform users' sorting. Hagiu (2009) studies exclusion of some low-quality types in order to increase average quality of one side of the market.

3 Model Setup

3.1 Timing

The game is in three stages. First, the platform offers the opportunity for components to join, either with unmanaged quality or with an exclusivity clause that limits a component's outside quality level to zero. The platform also chooses a fixed access price P_1 that consumers will pay to access the platform.

In the second stage, a total population of n component providers choose whether or not to accept the contract. Component providers have cost function

$$C(q_1, q_2) = q_1^2 + \gamma q_1 q_2 + q_2^2$$

where the term γ determines the component's type, namely whether it is a substitute type or not. Let γ=0 with probability ρ and γ=1 with probability (1-ρ), these are the neutral and substitute types respectively. Let $n_1 \leq n$ denote the number of component providers who actually join the platform.

Component providers receive revenue

$$R(q_1, q_2) = \beta D + p_2 q_2$$

where β is a parameter, D is the number of consumers who end up signing up for the platform, and p_2 is the price per unit of quality of the outside project. Note that a component provider's revenue from its inside project does not depend directly on q_1, but only indirectly through the number of consumers who sign up for the platform. We can think of the component providers being engaged in pure team production with their inside projects.

In the third stage, consumers choose whether or not to subscribe to the platform, and they also buy the outside project in a separate decision. Let a consumer of type θ receive utility from buying the platform of

$$U_1 = vn_1\bar{q}_1 - P_1 - \theta$$

Note that consumers care about both the number of components and the *average* quality of components on the platform. Parameter v indexes the value of quality to the consumer, while consumer type parameter θ is distributed uniformly on $[0,1]$.

Consumers also may purchase the outside projects of the components. Denote the number of components that offer outside projects by $n_2 \leq n$. The utility a consumer receives from these projects is

$$U_2 = (w - p_2)\bar{q}_2 n_2$$

where w is a parameter indexing reservation utility for quality of the outside projects and $\bar{q}_2$ is the average quality of the outside projects.

Note that the two utilities are additively separable, so they do not interact in the consumer's decision of whether or not to buy the platform. We will only need the utility U_2 for welfare analysis, not for finding the equilibrium of the game. For simplicity, we assume that p_2 is fixed.

3.2 Stage 3

We now solve backward to find a subgame-perfect equilibrium. Given $\overline{q}_1$, and n_1, all consumers with $U_1 > 0$ will subscribe to the platform, so

$$D(P_1, n_1, \overline{q}_1) = vn_1\overline{q}_1 - P_1$$

provided that $D \leq 1$.

3.3 Stage 2:

In Stage 2, the exclusivity provision has already been set. The components must decide whether or not to enter, and if so what quality to choose.

One possible case is that a component (of either type) chooses not to join the platform and to specialize on the outside project. In this case, it sets $q_1 = 0$, and this makes the cost functions of the two types become identical. An outside-specialized component solves

$$\max_{q_2} \Pi_2 = p_2 q_2 - q_2^2$$

This yields an optimal $q_2 = ½p_2$ and outside payoff

$$\Pi_2^* = ½p_2^2 - (½p_2)^2 = (½p_2)^2$$

The opposite case is that a component specializes on the inside project only. Either type might have to do this by contractual obligation, and a substitute type might do it voluntarily to avoid diseconomies of scope. An inside-specialized component sets $q_2 = 0$, which again makes the cost functions of the two types identical. The component then solves

$$\max_{q_1} \Pi_1 = \beta D(P_1, n_1, \overline{q}_1) - q_1^2$$

Denote the value of this problem by Π_1^*.

Finally, there is the case of a component that pursues both projects at the same time. An unspecialized neutral component solves

$$\max_{q_1, q_2} \Pi_{12}^N = \beta D(P_1, n_1, \overline{q}_1) + p_2 q_2 - q_1^2 - q_2^2$$

Denote the maximum by Π_{12}^{*N}.

If the substitute type pursues both projects, it solves

$$\max_{q_1, q_2} \Pi_{12}^{S} = \beta D(P_1, n_1, \overline{q}_1) + p_2 q_2 - q_1^2 - q_1 q_2 - q_2^2$$

Denote this maximum by Π_{12}^{*S}.

Each type of component will select between the above three candidate optima, selecting the one with the highest payoff.

3.4 Stage 1

In stage 1, the platform maximizes its own revenue, $P_1 D(P_1, n_1, \overline{q}_1)$. The demand function takes the form $D(P_1, n_1, \overline{q}_1) = v n_1 \overline{q}_1 - P_1$, so the first order condition for access price P_1 is

$$\frac{\partial P_1 D(P_1, n_1, \overline{q}_1)}{\partial P_1} = (v n_1 \overline{q}_1 - P_1) - P_1 = 0$$

Thus, all other things equal, the platform should set

$$P_1 = \frac{v n_1 \overline{q}_1}{2}$$

That is, the platform sets the consumer access price at one-half the demand intercept, i.e. the point where price elasticity of demand is unitary. This is the standard result for any monopolist with zero marginal cost and a linear demand curve.

4 Equilibria Under Different Contracts

We analyze the platform's maximization problem for two different types of contracts: (i) an unmanaged platform which restricts neither q_1 nor q_2, and (ii) an exclusive contract that specifies $q_2 = 0$ but leaves q_1 unmanaged.

In all of what follows, we focus on the cases where both component types join the platform ($n_1 = n$) and check that the relevant participation constraints are met. Clearly it would not be in the platform's interest to promote the case where zero components join the platform. The case of only neutral components joining is somewhat more interesting. But the platform would only prefer this case if the indirect network effect α and/or the proportion of substitute types (1-ρ) were low. If these were low enough, there would be little opportunity cost of excluding substitute types. However, the point of this paper is to give the platform the contractual flexibility to deal with the substitute types, suggesting that we are most interested in the case where the substitute types are too numerous and/or too valuable to ignore.

4.1 An Unmanaged Platform.

If the platform does not place any constraints on the behavior of the firms, then the neutral types will never specialize. Their profit maximization problems are:

$$\max_{q_1, q_2} \Pi_{12}^N = \beta D(P_1, n, \bar{q}_1) + p_2 q_2 - q_1^2 - q_2^2$$

Since this function is additively separable in q_1 and q_2, the optima are determined independently of one another. Note that any one component's inside quality decision affects the average only a little: $\frac{\partial \bar{q}_1}{\partial q_1} = \frac{1}{n}$. This means the first order condition for a neutral type's inside quality optimum is:

$$\frac{\partial \Pi_{12}^N}{\partial q_1} = \frac{\beta n v}{n} - 2q_1 = 0 \Rightarrow q_1 = \frac{\beta v}{2}$$

Note that this does not take account of the spillover to the other $n-1$ components, so there is a quality commons problem.

The first order condition for a neutral type's outside quality is

$$\frac{\partial \Pi_{12}^N}{\partial q_2} = p_2 - 2q_2 = 0 \Rightarrow q_2 = \frac{p_2}{2}$$

Substituting the optimal solutions into the objective function gives the optimal profits:

$$\Pi_{12}^{*N} = \beta(vn\bar{q}_1 - P_1) + \frac{p_2^2}{2} - \left(\frac{\beta v}{2}\right)^2 - \left(\frac{p_2}{2}\right)^2$$

The problem of a substitute type is more complicated because its cost function includes diseconomies of scope between the two quality levels. If it chooses to pursue both projects, it solves

$$\max_{q_1, q_2} \Pi_{12}^S = \beta D(P_1, n, \overline{q}_1) + p_2 q_2 - q_1^2 - q_1 q_2 - q_2^2$$

Assuming the interior solution exists, the first order conditions are:

$$\frac{\partial \Pi_{12}^S}{\partial q_1} = \frac{\beta n v}{n} - 2q_1 - q_2 = 0 \Rightarrow q_1 = \frac{\beta v}{2} - \frac{q_2}{2}$$

$$\frac{\partial \Pi_{12}^S}{\partial q_2} = p_2 - q_1 - 2q_2 = 0$$

Solving simultaneously gives:

$$p_2 - \frac{\beta v}{2} + \frac{q_2}{2} - 2q_2 = 0 \Rightarrow q_2 = \frac{2}{3} p_2 - \frac{\beta v}{3}$$

and

$$q_1 = \frac{2\beta v}{3} - \frac{1}{3} p_2$$

Substituting the optimal solutions into the objective function and simplifying gives the optimal profits:

$$\Pi_{12}^{*S} = \beta(vn\overline{q}_1 - P_1) + \frac{1}{3} p_2^2 - \frac{1}{3} \beta v \left(\beta v - p_2 \right)$$

Alternatively, the substitute type could specialize in the inside project only. In that case, it would solve:

$$\max_{q_1} \Pi_1 = \beta D(P_1, n, \overline{q}_1) - q_1^2$$

The solution is $q_1 = \frac{\beta v}{2}$ and the payoff is

$$\Pi_1^* = \beta(vn\overline{q}_1 - P_1) - \left(\frac{\beta v}{2} \right)^2$$

Using this analysis, several important results follow immediately.

Lemma 1: If all substitute types specialize, every component behaves like a neutral, and the average quality level is $\overline{q}_1^H = \frac{\beta v}{2}$.

Lemma 2: If all substitute types pursue both projects, the average quality level is

$$\overline{q}_1^L = \rho\frac{\beta v}{2} + (1-\rho)\left(\frac{2\beta v}{3} - \frac{1}{3}p_2\right)$$

which is lower than $\overline{q}_1^H$. This lower quality $\overline{q}_1^L$ is decreasing in the price of the outside project p_2.

Lemma 3: Average component quality is inefficiently low in an unmanaged equilibrium.

Proof: This follows from the quality commons formulation where average quality enters the payoff function. If substitute components specialized and all components colluded on quality, they would maximize $\beta(vn\overline{q}_1) - \overline{q}_1^2$ by choosing $\overline{q}_1$ and set $\overline{q}_1 = ½\beta vn$. If the substitute types remained unspecialized, the collusive quality would maximize, by choice of $\overline{q}_1$, some weighted average of Π_{12}^N and Π_{12}^S.

From here on, we will assume that on an unmanaged platform, the substitute type prefers to pursue both projects rather than specializing:

Outside Project Value (OPV) Assumption: The price of the outside project, w, is neither too low nor too high, so that a substitute-type component chooses an interior solution pursuing both projects whenever it chooses to participate in the platform:

$$\frac{\beta v}{2} \leq p_2 \leq 2\beta v \tag{OPV}$$

Our justification is simple: the point of this paper is to discuss components that might problematically pursue outside projects. If such components independently give up on such projects in order to specialize on the platform, or if they find such projects so valuable that they do not join the platform, they are not of interest here.

4.2 Exclusive contracts: $q_2 = 0$

We have seen that the inside quality level is too low due to the commons problem when the platform is unmanaged. Suppose that the only tool available to the platform to manage this problem is to ban outside projects, thus forcing $q_2 = 0$. Clearly such exclusivity will have a high cost, since neither type of component will receive the profits from the outside project. But there is also a benefit, because the inside quality produced by the substitute components will rise. Our question in this section is whether the quality increase can be enough to outweigh the cost and still meet the participation constraints.

From the previous section, it is clear that with the outside project removed, both types behave like the inside-specialized substitute type. We have seen that this leads to an optimal quality choice

$$q_1 = \frac{\beta v}{2}$$

and inside-specialized payoff

$$\Pi_1^* = \beta\left(vn\frac{\beta v}{2} - P_1\right) - \left(\frac{\beta v}{2}\right)^2$$

The first question is whether components would participate in a platform offering such a contract. This depends on the value of the outside project, namely whether

$$\Pi_1^* \geq \Pi_2^* \Rightarrow \beta\left(vn\frac{\beta v}{2} - P_1\right) - \left(\frac{\beta v}{2}\right)^2 \geq \frac{1}{4}p_2^2 \tag{PC}$$

Predictably, the participation constraint is met as long as the price the components receive for outside quality is not too high.

The next question is whether the platform actually gains from such a contract, and the answer here is clear:

Lemma 3: As long as the participation constraint is met, the platform gains from imposing exclusivity. The amount of this gain is

$$v^2 n^2 \frac{(\overline{q}_1^H)^2 - (\overline{q}_1^L)^2}{4}$$

Proof: The platform's payoff is simply $P_1 D(P_1, n, \overline{q}_1)$. This is always increasing in $\overline{q}_1$, so any policy that increases average quality will increase the platform's payoff. As discussed in section 3.4, the optimal interior value is $P_1 = \frac{vn\overline{q}_1}{2}$. Thus, the platform's gain is $\frac{(vn\overline{q}_1^H)^2}{4} - \frac{(vn\overline{q}_1^L)^2}{4}$ which simplifies as above.

Now let us turn to welfare analysis. This comes in four parts: the change platform producer surplus, the change in neutral-type producer surplus, the change in substitute-type producer surplus, and the change in consumer surplus.

We already saw the gain in platform producer surplus in Lemma 3. The change in a neutral type's producer surplus is given by

Lemma 4: A neutral type's payoff is higher on an exclusive versus unmanaged platform if

$$\frac{\beta vn}{2}(\overline{q}_1^H - \overline{q}_1^L) - \frac{p_2^2}{4} > 0$$

Proof: We are looking for the payoff difference

$$\Pi_1^*(\overline{q}_1^H) - \Pi_{12}^{*N}(\overline{q}_1^L)$$

This can be written out

$$\beta(vn\overline{q}_1^H - P_1) - \left(\frac{\beta v}{2}\right)^2 - \beta(vn\overline{q}_1^L - P_1) - \frac{p_2^2}{2} + \left(\frac{\beta v}{2}\right)^2 + \left(\frac{p_2}{2}\right)^2$$

If in both cases the platform sets P_1 equal to its optimal interior value, this can be simplified to the above.

This lemma is easily interpreted; the neutral types sees a gain in producer surplus due to the higher quality of the platform but a loss equal to its profits from the outside project.

Assuming we are in a case where the substitute type does not specialize on an unmanaged platform, a similar producer surplus comparison applies, although there is also some cost reduction due to avoiding diseconomies of scope.

Lemma 5: A substitute type's payoff is higher on an exclusive versus unmanaged platform if

$$\frac{\beta v n}{2}(\bar{q}_1^H - \bar{q}_1^L) + \frac{1}{12}\beta v - \frac{1}{3}p_2(p_2 - \beta v) > 0$$

Proof: We are looking for the payoff difference

$$\Pi_1^*(\bar{q}_1^H) - \Pi_{12}^{*S}(\bar{q}_1^L)$$

This can be written out

$$\beta(vn\bar{q}_1^H - P_1) - \left(\frac{\beta v}{2}\right)^2 - \beta(vn\bar{q}_1^L - P_1) - \frac{1}{3}p_2^2 + \frac{1}{3}\beta v\left(\beta v - p_2\right)$$

Again assuming an interior optimum for P_1, we have the expression in the lemma.

Finally we turn to the change in consumer surplus. This has two components, the loss of utility from the outside projects and the change in utility due to the increased quality of the inside projects.

Lemma 6: Consumers' payoffs are higher under an exclusive platform than an unmanaged one if

$$v^2 n^2 \frac{(\bar{q}_1^H)^2 - (\bar{q}_1^L)^2}{4} - (w - p_2)\bar{q}_2 n > 0$$

Proof: All consumers lose utility $U_2 = (w - p_2)\bar{q}_2 n$. Under OPV, the average quality of the outside projects is

$$\bar{q}_2 = \rho\frac{p_2}{2} + (1-\rho)\left(\frac{2}{3}p_2 - \frac{\beta v}{3}\right)$$

Consumer surplus from the platform is simply the net utility squared, since we have assumed a demand curve with slope of -1. Thus, the change in consumer surplus is

$$\left(\frac{vn\overline{q}_1^H}{2}\right)^2 - \left(\frac{vn\overline{q}_1^L}{2}\right)^2 = v^2n^2\frac{(\overline{q}_1^H)^2 - (\overline{q}_1^L)^2}{4}$$

This is the same as the platform's profit gain, since the platform's optimal price takes one-half the surplus from the consumers.

We are now in a position to evaluate whether the exclusivity provision can increase total surplus. The full sum from Lemmas 3–6 is

$$\begin{aligned}
& v^2n^2\frac{(\overline{q}_1^H)^2 - (\overline{q}_1^L)^2}{4} \\
+ \quad & \rho n\left(\frac{\beta vn}{2}(\overline{q}_1^H - \overline{q}_1^L) - \frac{p_2^2}{4}\right) \\
+ \quad & (1-\rho)n\left(\frac{\beta vn}{2}(\overline{q}_1^H - \overline{q}_1^L) + \frac{1}{12}\beta v - \frac{1}{3}p_2(p_2 - \beta v)\right) \\
+ \quad & v^2n^2\frac{(\overline{q}_1^H)^2 - (\overline{q}_1^L)^2}{4} - (w - p_2)\overline{q}_2 n
\end{aligned}$$

This can be simplified to

$$\begin{aligned}
& v^2n^2\frac{(\overline{q}_1^H)^2 - (\overline{q}_1^L)^2}{2} \\
+ \quad & n\frac{\beta vn}{2}(\overline{q}_1^H - \overline{q}_1^L) - \rho n\frac{p_2^2}{4} \\
+ \quad & (1-\rho)n\left(\frac{1}{12}\beta v - \frac{1}{3}p_2(p_2 - \beta v)\right) \\
- \quad & (w - p_2)\overline{q}_2 n
\end{aligned}$$

From this we can see several main results.

Most obvious, if the consumer valuation of the outside projects, w, is high, then there can be a social welfare loss from exclusivity despite its efficiency advantages.

Second, the difference between $\overline{q}_1^H$ and $\overline{q}_1^L$ is key to any gains from exclusivity. This difference, in turn, is increasing in the percentage of substitute types and the price of the outside project.

Finally, the price of the outside project enters directly since it reflects lost producer surplus from moving to an exclusive regime. However, it also negatively affects consumer surplus from these outside projects.

5 Conclusion and Extensions

This paper presents a simple model for thinking about the quality of components on a platform when those components produce both indirect network effects and a quality commons whereby average quality matters. The model includes some firms whose incentives are less aligned with those of the platform due to outside opportunities that are privately valuable but negatively impact the quality commons due to diseconomies of scope. In an environment where only an exclusive contract is available as a management tool, the average platform quality can be increased through exclusivity. This causes both gains and losses from a social welfare perspective, so it may or may not be a desirable behavior from a regulatory policy-maker's point of view.

A first extension is to provide a fuller welfare analysis describing the tradeoffs between the different parameters in greater detail. Another extension includes a model of platform ownership and decision-making, since we can expect a platform to make different decisions regarding exclusivity if it is owned privately, owned by some mixture of the component types, or owned by the consumers. Finally, the outside projects, rather than independent, might be collected on a platform of their own. Then exclusivity would serve two goals – the efficiency goal we have described here and a demand-side goal of reducing the number of components on the competing platform.

Works Cited

Armstrong, M. Competition in two-sided markets. RAND Journal of Economics (Jan 2006).

Boudreau, K., and Hagiu, A. Platform rules: Multi-sided platforms as regulators. papers.ssrn.com (2008).

Church, J., and Gandal, N. Network effects, software provision, and standardization. The Journal of Industrial Economics (Jan 1992).

Damiano, E., and Hao, L. Competing matchmaking. Journal of the European Economic Association (Jan 2008).

Hagiu, A. Pricing and commitment by two-sided platforms. RAND Journal of Economics (Jan 2006).

Hagiu, A. Quantity vs. quality and exclusion by two-sided platforms. papers.ssrn.com (2009).

Katz, M., and Shapiro, C. Network externalities, competition, and compatibility. The American Economic Review 75, 3 (Jun 1985), 424–440.

Rochet, J., and Tirole, J. Platform competition in two-sided markets. Journal of the European Economic Association (Jan 2003).