# Coordinating Through Platforms

Christiaan Hogendorn[*], Wolfgang H Gick[†‡]

June 11, 2007

**Abstract**

Firms often coordinate their actions to agree on technology standards, systems for transactions processing, strategic alliances, and so forth. In many cases there is an official platform, such as a standards body or a dominant manufacturer of infrastructure equipment that helps with the coordination. However, there are often some firms that would prefer certain types of coordination not to work, perhaps because of a weak competitive position with regard to a new technology or system. We present a signaling model of this situation and show the difficulties of separating the willing from unwilling firms. We focus on coordination among the firms themselves as a way of improving information available to the platform.

[*]Department of Economics, Wesleyan University.

[†]Department of Economics, Dartmouth College, 6106 Rockefeller Hall, Hanover, NH 03755-3514, ph. (603) 646-0641, fax (603) 646-2122, email: w.gick@dartmouth.edu

[‡]Center for European Studies, Harvard University.

# 1 Introduction

Firms need to make many types of exchanges in order to go about their operations. This raises issues of contracting, supply chains, compatibility, and interconnection. Complex exchanges are bundled with organizational capital. We believe the similarities are especially close with infrastructure industries, such as communications and transport, where interconnection and compatibility are especially important. Often there is a need to invest in new infrastructure or organizational capital, but this causes problems with contracting and spillovers.

A comparable situation is when there are fixed costs associated with producing an intermediate good, so there must be sufficient demand for even one firm to enter the market. The reason for too little demand may be because the good is not used by enough final good producers in a particular location or industry. Coordinated investments in infrastructure, organizational capital, and private capital to use the intermediate good can overcome these problems of limited demand or supply and thus increase the product variety available.

In some cases the barrier to the first firm(s) has already been overcome, but there is still a limited number of firms and therefore a monopoly or oligopoly situation. Then even more coordinated investment may push the market toward competition.

In this paper, we focus on choices that platform providers can make to internalize search costs by coordinating the actions of their customers. Besides advertising and pricing, platforms use other modes of information disclosure to coordinate their users. Similarly, multi-sided platforms provide services to application developers, hardware manufacturers, and end-users. That is, each group needs the others to participate for the platform to generate market value. Using a signaling model we study why, in some cases, there are different forms of equilibria in a multiplayer setting. We observe that some equilibria are Pareto superior to others. For these cases, agents all agree on the desirability of coordination, but they may need platform(s) to facilitate it. In other cases,

the desired equilibrium is superior for some but not all agents. Then, platform(s) use transfers, exclusion, or forms of market power to reach the equilibrium. The paper discusses the findings using a comparison of different platform models.

## 2 Literature Review

There is a considerable body of literature noting how difficult the coordination problem can be. For example, Frischmann (2005) suggests that infrastructure is often best managed as a "commons" to ensure wide use. A very different paper that also uses the commons approach is Koulovatianos and Mirman (2006), which models dynamic rivalry in an industry that requires some specific, rival capital that is not excludable. Actually, this is in some ways a contemporary approach to Marshall's "external economies of scale," which he claimed would lead to socially suboptimal investment – though this claim was widely debunked in the early 20th century, see Papandreou (1994).

The idea of coordination difficulties is also prominent in the literature on the theory of the firm. In a now classic contribution, Alchian and Demsetz (1972) argued that managers' power is not based on fiat, but rather on their centralized, coordinating position. Hart (1995, pg. 56) stresses that there must be some "glue" keeping the workers of the acquired firm from leaving: "The source of value may even just represent the difficulty firm 2's workers face in co-ordinating a move to another firm." However, the property rights approach to firms that Hart and other have developed goes on to look more at marginal incentives to invest in a transaction rather than the coordination problems themselves.

One interesting approach to the coordination problem is Raskovich's (2003) paper on "pivotal buyers," that is buyers who are so large that their participation determines whether a supplier produces or not. Another is Chen and Ross (2000), who look at firms' strategic decision to share a "terminal" facility. A more direct approach is to study coordination games themselves. Cooper (1999) provides a good treatment,

though with a focus on macroeconomic applications.

In this paper, we look at the coordination problem through the idea of a two-sided network. For Rochet and Tirole (2003), the platform's raison d'être is to coordinate the actions of the two sides. However, their agents are atomistic, and therefore nonstrategic in their decisions about which platforms to join. Caillaud and Jullien (2003) focus a bit more on coordination because their platform is explicitly a "matchmaker," but their agents are also atomistic.

The aspect of the two-sided markets that is particularly relevant to us is the idea of the platform influencing coordination on one of multiple equilibria. Pashigian and Gould (1998) have shown that shopping mall platform providers use different pricing strategies for retailers' space to internalize demand spillovers in the presence of search costs for consumers. Smith and Hay (2005) and Hagiu (2006) investigate different types of platforms with more or less control over the network effects generated by the sides of the market. Doganoglu and Wright (2006) examine the (non-strategic) choice of multi-homing versus the (strategic) choice of compatibility, showing that the they are no perfect substitutes for each other.

Ambrus and Argenziano (2004) have directly modeled the equilibrium selection process in network markets. Hogendorn and Yuen (2007) have investigated "must-have" components that strategically choose a platform based on their expected network effect.

## 3 The Apprentice Game

The game we have in mind involves several firms, some of which want to coordinate their actions to achieve a cooperative end. However, at least one firm does not gain from the cooperation and may want to act as a spoiler. There is a platform which brings the firms together. If it were somehow possible to get rid of the spoiler firm, the whole platform could operate more productively. We believe this setting captures the idea of several large firms trying to cooperate on, say, a technology standard

or a billing system, where one of the firms actually would prefer the project to fail while the others want it to succeed.

### 3.1 Basic Setup

The game consists of four players, a platform and three firms of different types. Two firms are of type $H$, one is of type $L$. A firm of type $H$ contributes output $o_H$ to the platform, while the $L$-type produces $o_L$, with $o_H > o_L$. Each firm receives the same fixed payment from the platform $w$, with $o_H > w > o_L$. That is, the $H$-types are worth more than their money, the $L$-type is not. We consider three possible alliance constellations at the beginning, not all of them being equilibrium outcomes in the game:

- **Case 1**: All 3 firms join the platform: $\pi_3 = 2o_H + o_L - 3w$
- **Case 2**: 2 firms join, both $H$-types: $\pi_2^{HH} = 2o_H - 2w$
- **Case 3**: 2 firms join, of different types: $\pi_2^{LH} = o_H + o_L - 2w$
- **Case 4**: 1 firm joins, of type $H$: $\pi_1^H = o_H - w$
- **Case 5**: 1 firm joins, of type $L$: $\pi_1^L = o_L - w$

These payoffs can be ordered as follows. Note that getting rid of the $L$ type would improve the system.

$$\pi_2^{HH} > \pi_3 > \pi_1^H > \pi_2^{LH} > 0 > \pi_1^L. \tag{1}$$

In the broader sense, our firm $F$ can be thought of as a platform, a market, or something like a "commons" in the minimalist sense; it has little to do with a sophisticated agency endowed with control instruments to verify each agent's effort. Consequently, it has little information about each firm's type but uses the firm's actions to receive some information about the types.

### 3.2 Information

Information accrues as follows. Any firm can choose to invest at $t = 1$ and the platform chooses which firms to include at $t = 2$, following what it learns about the investments at $t = 1$. Each firm knows only its own type, but it is common knowledge among all players that there are only two $H$-type firms and one $L$-type firm.

Each firm's payoff is $w + x$. The platform imposes a negative penalty on all firms in form of a nonmonetary loss (deterring work atmosphere, barred access to existing perks etc.). The penalty can be understood as a nonmonetary loss that in the default situation affects all firms equally, but may be changed in due course once information is revealed differently along the time line. The reason for the penalty is the dishonesty of the one $L$ type firm. Without knowing which is the $L$ type, the platform must impose fairly harsh controls on all the firms to prevent stealing. The penalty is costly (cost $=x$ per firm) for the platform to impose, but if the platform admits the $L$ type firm and does not impose the penalty, there is a large negative payoff ("boiling in oil"), so the platform will always avoid this.

To keep things simple, we will assume that all firms have an outside option of 0. This is common knowledge. At $t = 1$, the firms each choose strategy $s_i \in \{\text{invest}, \text{no invest}\}$; the strategy profile of all the workers is $\mathbf{s} = (s_1, s_2, s_3)$, but for clarity we often write expressions such as "3 invest" or "2 no invest." At $t = 2$ the platform has beliefs $\mu(\mathbf{s})$ that an investing firm is type $H$ and beliefs $\sigma(\mathbf{s})$ that a non-investing firm is type $H$. The platform chooses strategy $s_F(\mathbf{s}) = (n, X_R, X_S)$ where $n \in \{1, 2, 3\}$ is the number of investors to accept, $X_R \in \{0, x\}$ is the level of penalty to imposed on the accepted firms, and $X_S \in \{0, x\}$ is the level of penalty to impose on the firms that do not invest.

**Proposition 1** *There is a pooling equilibrium with all firms choosing to invest and the platform accepting all of them, but the platform must impose the penalty.*

**Proof:** By Bayes' Rule, the platform must hold beliefs $\mu(3 \text{ quit}) = 2/3$ because the investment decision carries no information. The expected payoffs of the platform are:

$$EV(1, x, x|3 \text{ invest}) = \tfrac{2}{3}\pi_1^H + \tfrac{1}{3}\pi_1^L - x$$
$$EV(2, x, x|3 \text{ invest}) = \tfrac{1}{3}\pi_2^{HH} + \tfrac{2}{3}\pi_2^{LH} - 2x$$
$$EV(3, x, x|3 \text{ invest}) = \pi_3 - 3x$$

Provided $x$ is not too large, $\pi_3 > EV(2, x, x|3 \text{ invest}) > EV(1, x, x|3 \text{ invest})$.

The beliefs $\sigma(1 \text{ no-invest})$ are off the equilibrium path, but to support the platform's strategy of imposing the penalty on non-investors requires that $\sigma$ not be too low.

Any firm that deviated and chose $s_i =$ no-invest would still receive payoff $w - x$, so there is no incentive to deviate. This completes the proof. ■

Note that perfect Bayesian equilibria (and Nash equilibria in general) do not require us to consider *coordinated* deviations. However, those might exist and destroy the pooling equilibrium, if $\sigma(2 \text{ no-invest})$ and $\sigma(3 \text{ no-invest})$ supported it.

**Proposition 2** *There is no separating equilibrium in which both H types invest and the L type does not invest.*

**Proof:** In the separating equilibrium, the platform must hold beliefs $\mu(2 \text{ invest}) = 1$ and $\sigma(2 \text{ invest}) = 0$. With these beliefs, the platform would impose the penalty *only* on the 1 non-investing firm and would receive payoffs:

$$EV(0, 0, x|2 \text{ invest}) = \pi_1^L - x$$
$$EV(1, 0, x|2 \text{ invest}) = \pi_2^{LH} - x$$
$$EV(2, 0, x|2 \text{ invest}) = \pi_3 - x$$

Comparing the payoff situations shows that

$$EV(2, 0, x|2 \text{ invest}) > EV(1, 0, x|2 \text{ invest}) > EV(0, 0, x|2 \text{ invest})$$

so the platform would accept both investing firms.

Suppose two firms invest. If the third firm also invests, the equilibrium is thrown back to the pooling case, and the investor receives $w-x$. If the third firm does not invest, it is believed to be an $L$ type and also receives $w-x$. Therefore the third firm will weakly not deviate.

The two investing firms receive $w$, but they would receive $w-x$ if they did not invest; therefore they do invest.

The above does not depend on the identity of the two firms. Therefore the beliefs suggested above cannot be in equilibrium. In fact, the beliefs should be the probability that 2 draws from the 3 firms, without replacement, lead to an $L$ firm being among the two. This is $\frac{1}{3}+\frac{2}{3}\frac{1}{2}=\frac{2}{3}$. Thus we must have $\mu(2 \text{ invest})=\frac{2}{3}$ and $\sigma(2 \text{ invest})=\frac{1}{3}$. These beliefs do not support the equilibrium. ■

# 4 Summarizing

So far we have described a situation where (most) agents would prefer a separating equilibrium, but such an equilibrium does not exist. The problem we have identified is that the platform's beliefs are based on *uncoordinated* investment of 2 firms, and this does not give the platform any mechanism to be assured that the investing firms are the $H$ type.

One way to solve this problem is to change the incentives of the agents, giving them different payoffs depending on their types. In the setting as we have described it, however, it is not clear how this could be done.

The other solution, and the one we want to focus on in the future, is coordination among the firms. Note that with more than one sender, beliefs are no longer independent (Hertzendorf and Overgaard, 2000; Gick, 2006). If the platform knew that the 2 firms had coordinated before investing, this might convey some additional information, thus relaxing the constraint on the beliefs and possibly supporting the separating equilibrium. This can be the case if two H-firms coordinate to invest and the platform holds beliefs that they will, then there may be additional

equilibria to be discussed. That is, we move toward a theory of platform coordination in which platforms can be differentiated by the ease of coordinating to support beliefs that result in separating equilibria.

## References


Alchian, Armen A. and Demsetz, Harold. "Production, Information Costs and Economic Organization," *American Economic Review,* 62 (5), 1972. 777–795.

Attila Ambrus and Rossella Argenziano, "Network markets and consumer coordination," March 2004.

Zhiqi Chen and Thomas Ross, Strategic Alliances, Shared Facilities, and Entry Deterrence, *RAND J.,* Summer 2000

Russell Cooper, *Coordination Games: Complementarities and Macroeconomics,* Cambridge University Press, 1999.

Toker Doganoglu and Julian Wright, "Multihoming and compatibility," *International Journal of Industrial Organization,* 24(1), 2006: 45–67.

B.M. Frischmann, "An Economic Theory of Infrastructure and Commons Management." Minnesota Law Review, 89, 2005.

Gick, W., 2006, "Little firms and big patents. International patent filing incentives and competition for technology partners." mimeo, available at http://www.dartmouth.edu/ wgick/pat.pdf

Andrei Hagiu, "Merchant or Two-Sided Platform?" December 6, 2006.

Hertzendorf, M.N. and P.B. Overgaard, 2000, "Will the high-quality

producer please stand up? - A model of duopoly signaling," mimeo.

Hogendorn, C. and K. Yuen, "Platform Competition with 'Must-Have' Components," Working Paper, 2004.

Koulovatianos and Leonard Mirman, "The effects of market structure on industry growth: Rivalrous non-excludable capital," *Journal of Economic Theory,* 2006.

Andreas Papandreou, *Externality and Institutions,* Oxford: Clarendon, 1994.

Pashigian, B. P., and E. D. Gould (1998) "Internalizing Externalities: The Pricing of Space in Shopping Malls," *Journal of Law and Economics,* 41(1), 115–142.

Alexander Raskovich, "Pivotal Buyers and Bargaining Position," *Journal of Industrial Economics,* 51(4), 2003: 405–426.

Jean-Charles Rochet and Jean Tirole, "Platform Competition in Two-Sided Markets," *Journal of the European Economic Association,* 2003.

Howard Smith and Donald Hay, "Streets, Malls, and Supermarkets," *Journal of Economics and Management Strategy,* 14(1), 2005: 29–59.