Competition, bargaining power and pricing in two-sided markets

Wilko Bolt [a,*]

[a] *Research Department, De Nederlandsche Bank, Amsterdam, The Netherlands*

Kimmo Soramäki [b]

[b] *Systems Analysis Laboratory, Helsinki University of Technology, Helsinki, Finland*

Abstract

We develop a model of two-sided markets with a focus on the the role of bargaining power between the two sides of the market. We are interested in the profit maximising usage fees set by homogeneous duopolistic platforms. We find that for a sufficiently low cost level, in Nash-equilibrium all costs are borne by the side without bargaining power. For higher cost levels, the prices do not converge but end up in a cycle. The equilibrium price level allows excess profits for both platforms.

Key words: platform competition, bargaining power, equilibrium pricing, excess profits

Jel Codes: L10, L13

1 Introduction

Recently a burgeoning literature has emerged investigating the impact of competition on price level and price structure in two-sided markets (e.g., Armstrong, 2006; Armstrong and Wright, 2007; Rochet and Tirole, 2003). The models used for the study of two-sided markets can broadly be categorized as usage models, membership models and combinations thereof (Rochet and

* Corresponding author.
Email addresses: `w.bolt@dnb.nl` (Wilko Bolt), `kimmo@soramaki.net` (Kimmo Soramäki).

Tirole, 2006). In usage models the two sides of the market pay individually for each transaction, while in membership models they pay a fixed fee for an uncertain number of future transactions.

We develop a usage model of two-sided markets with a focus on the the role of bargaining power between the two sides of the market. We analyze profit maximising usage fees simultaneously set by duopolistic homogeneous platforms. We assume that both buyers and sellers can use the platform without the need to become members, or where becoming a member does not carry a cost (i.e a zero fixed fee). As such the model reflects real-life markets such as mature credit cards, securities brokerage or mature telecoms.

Bargaining power plays a crucial role when both sides of the market can use more than one platform. Each side might prefer a different platform, but would also prefer to complete the transaction on a less preferred platform, instead of foregoing it. Hermalin and Katz (2006) consider this scenario in the framework of a strategic game of routing rules, that endogenously determines the party who gets to choose the platform. In this paper we take the outcome of any bargaining process as given and investigate the effect of bargaining power on pricing equilibria.

We find that for a sufficiently low cost level, in Nash-equilibrium all costs are borne by the side without bargaining power. For higher cost levels, the prices do not converge but end up in a cycle. Compared to a monopoly outcome, competition generally increases the price of the side without bargaining power, but overall lowers the total price charged to both sides. The equilibrium price level, however, still allows excess profits for both platforms.

As reported in Evans (2003), in practice many two-sided platforms tend to treat one side of the market as a "profit center" with high prices and the other side as a "loss leader" with low prices. We argue that these heavily skewed pricing strategies may result from a difference in bargaining power between the two sides.

2 The model

Two identical platforms, P_1 and P_2, supply a "joint" service to both buyers and sellers, who derive utility from simultaneously transacting on a platform.

Assumption 2.1 *[Two-sided Multihoming]*
Platforms do not charge fixed membership fees and there are no transaction costs in joining the platform. Hence, buyers and sellers fully multihome.

Platform k charges buyers and sellers a (per-transaction) usage fee, denoted by p_b^k and p_s^k, $k = 1, 2$. Both platforms incur a marginal cost $c \geq 0$ per transaction. Buyers and sellers are heterogeneous in the utility they receive from a transaction. To analytically track the competition game between the two platforms we assume uniform distributions.

Assumption 2.2 *[Uniform distribution]*
Buyers and sellers heterogeneity is described by uniform distributions. That is, $u_i \sim U[a_i, b_i]$, $i = b, s$.

Hence, the probability density functions are given by $h_i(x) = 1/(b_i - a_i)$ and cumulative density by $H_i(x) = (x - a_i)/(b_i - a_i)$. Robustness of this assumption is briefly discussed in section 4.

Buyers prefer the platform with the lowest price as long as $u_b \geq \min\{p_b^1, p_b^2\}$. If $u_b < \min\{p_b^1, p_b^2\}$, neither platform is used as both prices are too high. For equal prices $u_b \geq p_b^1 = p_b^2$, the buyer is indifferent and both platforms are equally likely to be chosen. The same reasoning holds for sellers. In case both platforms are acceptable to both sides, i.e. $u_b \geq \max\{p_b^1, p_b^2\}$ and $u_s \geq \max\{p_s^1, p_s^2\}$, the distribution of bargaining power, characterized by $\tau \in \{0, 1\}$, determines the choice of platform. With full bargaining power by buyers, $\tau = 1$, the transaction is conducted on the buyer's preferred platform. The reverse holds for full bargaining power by sellers, $\tau = 0$. [1] Without loss of generality–since the game is symmetric–we will assume full bargaining power by buyers. That is, we assume $\tau = 1$ throughout the paper.

Let us denote platform 1's demand function by $D^1((p_b^1, p_s^1), (p_b^2, p_s^2))$ and its profit function by $\Pi^1((p_b^1, p_s^1), (p_b^2, p_s^2)) = (p_b^1 + p_s^1 - c)D^1((p_b^1, p_s^1), (p_b^2, p_s^2))$. Given platform 2's prices $p^2 = (p_b^2, p_s^2) \in \mathbb{R}^2$, platform 1 sets her price $p^1 = (p_b^1, p_s^1) \in \mathbb{R}^2$ so as to maximize her own profits. We define the best reply function, $BR^1(\cdot) : \mathbb{R}^2 \to \mathbb{R}^2$, such that

$$BR^1(p^2) = \arg\max_{p^1} \left\{ \Pi^1((p_b^1, p_s^1), (p_b^2, p_s^2)) \right\}.$$

A maximum always exists if we assume a smallest unit of account $\epsilon > 0$, implying that platforms cannot undercut by a smaller amount than ϵ. As is shown in the appendix, given platform 2's prices (p_b^2, p_s^2), platform 1 must evaluate nine different "price regions" to calculate her own demand function. We assume that both platforms simultaneously set prices.

[1] In Bolt and Soramki (2007), we also study intermediate bargaining power positions $\tau \in (0, 1)$ that define a probability statement about the choice of platforms.

3 Equilibrium prices

To describe best-reply price dynamics in a two-sided market between two homogeneous platforms four price vectors, $p \in \mathbb{R}^2$, are of particular importance:
i) the starting price $p^0 = (p_b^0, p_s^0)$,
ii) the monopolistic price $p^M = (p_b^M, p_s^M)$,
iii) the "corner" price $p^C = (a_b, p_s^C)$, and
iv) the "best reply" to the corner price $p^{BR} = BR(p^C)$.

Using Rochet-Tirole's (2003) theorem on monopolistic price-setting in two-sided markets, it is easy to verify that in the uniform case:

$$p^M = \left(\frac{1}{3}(2b_b - b_s + c), \frac{1}{3}(2b_s - b_b + c)\right), \tag{1}$$

and some further calculations show

$$p^C = \left(a_b, \frac{1}{2}(b_s - a_b + c)\right). \tag{2}$$

To describe the sequence of best replies, let us assume without loss of generality that the (symmetric) starting point describes a "zero profit" situation ($p_b^0 + p_s^0 = c$), in which both platforms split the market with equal demand. For now, we assume $p_b^0 > p_b^M$, and consider the following lemma.

Lemma 3.1 *[Monopolistic Best Reply]*
Given $\tau = 1$, the best reply to a price $p^0 \in R^2$ of platform 2 is the monopolistic price p^M if $p_b^0 > p_b^M$. That is,

$$BR^1(p^0) = p^M, \quad \textit{if} \;\; p_b^0 > p_b^M. \tag{3}$$

Proof. By undercutting on the buyers side, platform 1 will attract all the demand of buyers with utility $u_b \geq p_b^M$. Since buyers have all bargaining power ($\tau = 1$), the seller's price can be raised to p_s^M. Sellers with utility $u_s \geq p_s^M$ would obviously prefer to transact on the other platform, but are still willing to do business with platform 1, which is the preferable platform for buyers because her lower price. Naturally, the optimal tradeoff between attracting buyers and sellers occurs at the monopolistic outcome which yields maximum profits for platform 1. □

Hence, coming from a zero-profit situation, competition between two identical platforms leads to the monopolistic outcome as the best reply. Obviously, the monopolistic outcome p^M is not an equilibrium outcome, and platform 2 will strategically deviate from it by playing its best reply. This will trigger a phase of "ϵ-undercutting" prices on the buyer's side.

Lemma 3.2 *[Undercutting Phase]*
Given $\tau = 1$ and $\epsilon > 0$, competition between homogeneous platforms drives prices from the monopolistic price p^M to the corner price p^C. That is,

$$BR^1(p^2) = (p_b^2 - \epsilon, p_s^2 + h), \quad \textit{if} \;\; p_b^2 \leq p_b^M, \tag{4}$$

where optimal "overpricing" h is given by

$$h(p_b, p_s) = \frac{1}{2}(b_s - p_b + c) - p_s. \tag{5}$$

Proof. Given monopoly prices (p_b^M, p_s^M), platform 1 may consider to undercut on the seller's side. Undercutting on the seller's side by ϵ attracts some additional demand of order ϵ, but loses on the margin by the same order of ϵ. Since buyers have all bargaining power, sellers are not able to steer to the platform with the lowest price. Buyers will just randomize their choice for either of the two platforms with equal probability. In contrast, ϵ-undercutting on the buyers' side, will gain extra leverage. Now, buyers are fully steered to the cheaper platform, which will increase platform 1's demand by a factor of two, while the price margin only slightly deteriorates. Moreover, undercutting on the buyers' side allows some overpricing on the sellers' side. The optimal amount of overpricing is determined by solving the quadratic problem

$$\max_h \left\{ \Pi^i((p_b^1, p_s^2 + h), (p_b^2, p_s^2)) \right\}, \quad \text{with} \;\; p_b^1 < p_b^2,$$

which yields $h(p_b^1, p_s^2)$. This process of ϵ-undercutting will continue until the buyers' price hits the lower boundary a_b, while the sellers price converges to the corner price p_s^C, since $h(a_s, p_s^C) = 0$. □

Note that for any price $p^0 = (p_b^0, p_s^0)$ with $p_b^0 \leq p_b^M$ the best reply is given by $BR^1(p^0) = (p_b^0 - \epsilon, p_s^0 + h(p_b^0 - \epsilon, p_s^0))$. The question arises whether (p^C, p^C) is a Nash equilibrium. This will depend on the cost level relative to the spread of the buyers and sellers uniform distributions.

Lemma 3.3 *[Corner Best Reply]*
Denote $p^{BR} = (\frac{1}{6}(4b_b + a_b - b_s + c), \frac{1}{3}(b_s - b_b - a_b + 2c))$. Given $\tau = 1$, we find

$$BR(p^C) = \begin{cases} p^C, & \textit{if} \;\; c < b_s - (b_b - 2a_b), \\ p^{BR}, & \textit{if} \;\; c \geq b_s - (b_b - 2a_b). \end{cases} \tag{6}$$

Proof. Given $p^2 = p^C$, the only viable strategy $p^1 \neq p^C$ for platform 1 is to overprice on the buyer's side and to undercut on the seller's side. Given this strategy, the first-order conditions of $\max_{p^1}\{\Pi^1(p^1, p^C)\}$ yield $p^1 = p^{BR}$, which is a (local) maximum. It is easy to verify that $\Pi^1(p^{BR}, p^C) < \Pi^1(p^C, p^C)$ if and only if $c < b_s - (b_b - 2a_b)$. □

The following proposition easily follows from above three lemmas.

Proposition 3.4 *[Nash Equilibrium]*
Denote $c^* = b_s - (b_b - 2a_b)$. Given $\tau = 1$, competition between homogeneous platforms yields Nash equilibrium prices (p^C, p^C) if and only if $c < c^*$. Otherwise, no equilibrium exists, and best-reply price dynamics yield a price cycle.

It can be readily shown that $c < p_b^C + p_s^C \leq p_b^M + p_s^M$ holds for $c^* - (b_b - a_b) \leq c \leq c^*$, implying that platform competition generally reduces the monopolistic total price level, but that excess profits still remain in equilibrium.

4 Examples and robustness

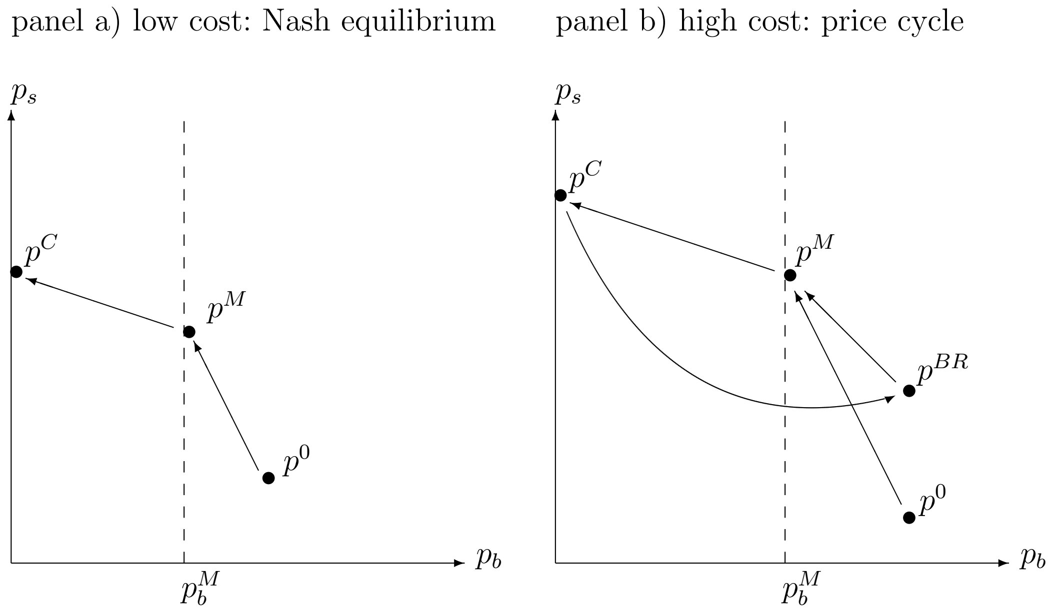
To illustrate our findings, assume $u_b = [0, 1]$, $u_s = [0, 2]$, $\tau = 1$, $c_0 = 3/4$, and $\epsilon = 1/100$ (a "cent"). Our results yield: $p^M = (1/4, 5/4)$, $p^C = ((0, 11/8)$, and $c^* = 1$. Since $c_0 < c^*$, Nash equilibrium prices are $((0, 11/8), (0, 11/8))$. The best-reply price dynamics is illustrated in the left panel of the figure 1. The process will go $p^0 \to p^M \to p^C$.

With higher cost $c = 5/4 > c^*$, best reply dynamics will not converge, but end up in a cycle. We calculate: $p^M = (5/12, 17/12)$, $p^C = (0, 13/8)$, and $p^{BR} = (13/24, 7/6)$. Starting at a zero profit (symmetric) situation with $p^0 = (5/8, 5/8)$, the best-reply price dynamics end up in a price cycle, which is illustrated in the right panel of the figure 1 The process will go $p^0 \to p^M \to p^C \to p^{BR} \to p^M \to p^C \to \ldots$.

The uniform distribution allows analytical results. To check robustness, we performed numerical analyzes using (transformed) beta distributions $B_{p,q}(x)$ that allow varying densities on $[a_i, b_i]$. The numerical results confirm our analytical findings for the uniform distribution. When we e.g. used a beta $B_{2,3}(x), x \in [0, 1]$ for the buyers, and $B_{4,8}(y), y \in [0, 2]$, we verify $p^M = (0.17, 1.19)$ and Nash equilibrium $(p^C, p^C) = ((0, 1.25), (0, 1.25))$ for cost level $c = 3/4$. For $c = 5/4$, prices end up in a cycle. Similarly, for a log-normal distribution we find convergence to Nash equilibria for low cost levels with the buyers equilibrium price being zero, but price cycles for higher cost levels.

Critically, for convergence, we need left finite support of the density function, i.e. $a_i > -\infty$. Applying a normal density distribution did not show convergence for any non-negative cost level, only price cycles. However, as a justi-

Fig. 1. Platform competition and best reply dynamics



fication, it would not seem very plausible that (some) agents have infinitely negative valuations for platform services.

References

[1] Armstrong, M., 2006, Competition in two-sided markets, Rand Journal of Economics 37, 668-691.

[2] Armstrong, M and J. Wright, 2007, Two-sided markets, competitive bottlenecks and exclusive contracts, Economic Theory 32, 353-380.

[3] Bolt, W and K. Soramki, 2007, Platform competition, bargaining power and pricing in two-sided markets, Mimeo.

[4] Evans, D., 2003, Some empirical aspects of multi-sided platform industries, Review of Network Economics 2, 191-209.

[5] Hermalin, B. and M. Katz, 2006, Your network or mine? The economics of routing rules, Rand Journal of Economics 37, 692-719.

[6] Rochet, J-C. and J. Tirole, 2003, Platform competition in two-sided markets, Journal of the European Economic Association 1, 990-1029.

[7] Rochet, J-C and J. Tirole, 2006, Two-sided markets: A progress report, Rand Journal of Economics 37, 645-667.

Appendix

Let the utility for buyer $u_b \sim U\left[a_b, b_b\right]$, and the seller $u_s \sim U\left[a_s, b_s\right]$. The prices set by the two platforms for the buyers and sellers are denoted by $(p^1, p^2) = \left(\left(p_b^1, p_s^1\right), \left(p_b^2, p_s^2\right)\right)$. Let $\tau = \{0, 1\}$ denote bargaining power between the buyer and seller. The demand for platform 1 is given by:

$$D^1(p^1, p^2|\tau) = \begin{cases} \frac{\left(b_b - p_b^2\right)\left(p_s^2 - p_s^1\right) + \left(b_b - p_b^2\right)\left(b_s - p_s^1\right) + \left(p_b^2 - p_b^1\right)\left(b_s - p_s^2\right) + \left(p_b^2 - p_b^1\right)\left(p_s^2 - p_s^1\right)}{(b_b - a_b)(b_s - a_s)} & p_b^1 < p_b^2 \wedge p_s^1 < p_s^2 \\ \frac{\left(b_b - p_b^1\right)\left(p_s^2 - p_s^1\right) + (1-\tau)\left(b_b - p_b^1\right)\left(b_s - p_s^2\right)}{(b_b - a_b)(b_s - a_s)} & p_b^1 > p_b^2 \wedge p_s^1 < p_s^2 \\ \frac{\left(p_b^2 - p_b^1\right)\left(b_s - p_s^1\right) + \tau\left(b_b - p_b^2\right)\left(b_s - p_s^1\right)}{(b_b - a_b)(b_s - a_s)} & p_b^1 < p_b^2 \wedge p_s^1 > p_s^2 \\ \frac{0.5\tau\left(b_b - p_b^1\right)\left(b_s - p_s^1\right)}{(b_b - a_b)(b_s - a_s)} & p_b^1 = p_b^2 \wedge p_s^1 > p_s^2 \\ \frac{(1-0.5\tau)\left(b_b - p_b^1\right)\left(b_s - p_s^2\right) + (1-0.5\tau)\left(b_b - p_b^1\right)\left(p_s^2 - p_s^1\right)}{(b_b - a_b)(b_s - a_s)} & p_b^1 = p_b^2 \wedge p_s^1 < p_s^2 \\ \frac{0.5\tau\left(b_b - p_b^1\right)\left(b_s - p_s^2\right)}{(b_b - a_b)(b_s - a_s)} & p_b^1 = p_b^2 \wedge p_s^1 = p_s^2 \\ \frac{0.5(1-\tau)\left(b_b - p_b^1\right)\left(b_s - p_s^1\right)}{(b_b - a_b)(b_s - a_s)} & p_b^1 > p_b^2 \wedge p_s^1 = p_s^2 \\ \frac{0.5(1+\tau)\left(b_b - p_b^2\right)\left(b_s - p_s^1\right) + \left(p_b^2 - p_b^1\right)\left(b_s - p_s^1\right)}{(b_b - a_b)(b_s - a_s)} & p_b^1 < p_b^2 \wedge p_s^1 = p_s^2 \\ 0 & p_b^1 > p_b^2 \wedge p_s^1 > p_s^2 \end{cases}$$