Managing Adoption under Network Effects

Extended Abstract*

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CCS Concepts

• **Networks** → *Network economics.*

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The consumption of several modern products is marked by strong network effects, i.e., the utility to a consumer improves with the overall adoption in the market. Examples include mobile platforms that significantly rely on user-generated content, social media platforms, massively multiplayer games, cryptocurrencies, etc. For a firm that intends to launch a new product in this space, the biggest initial challenge is to stimulate sufficient adoption through appropriately designed incentives – a problem that is exacerbated by the presence of strategic consumers who anticipate the informational benefits of delaying their adoption decisions.

In this paper, we present a new microeconomic analysis of adoption dynamics in the presence of network effects, which reveals the root cause of adoption inertia amongst buyers to be the prior public uncertainty about the overall interest in the product across the market and hence the anticipated adoption level. In particular, we demonstrate the *necessity* of promotional discounts to stimulate adoption in the presence of such perceptional uncertainty by showing that no-adoption is the only equilibrium when a single price is offered. We then proceed to our main contribution, which is to present crisp insights into the design of effective promotional pricing strategies by systematically uncovering their role in managing buyers' beliefs.

Formally, we consider a stylized model that captures two main features of the setting we intend to study: a) product consumption is marked by network effects, and b) there is prior uncertainty about the perception of the product across the market. We assume that the set of buyers is a continuum, identified with the set $[0, 1]$. Each buyer is associated with an *internal valuation* v that only she knows, whose distribution across the population is modeled as $N(\mu, \sigma^2)$. A buyer's internal valuation can be interpreted as her marginal utility per unit mass of adoption in the market. If ρ is the mass of the set of buyers that adopts the product, then the utility of an adopting buyer with internal valuation v, and who has paid a price p, is $v\rho - p$. We assume that σ and the prior distribution of μ, modeled as $N(\mu_0, \sigma_0^2)$, are both commonly known to the firm and the buyers. But μ, which we naturally refer to as the *average perception* of the product across the market, is a priori unknown. We focus on a pricing strategy where the firm announces a reduced price in an early promotional phase to eliminate adoption inertia and a higher regular price for purchases made after this phase. An important aspect of the model is that by delaying their adoption decisions until the second phase, the buyers get to observe the adoption in the first phase and thus learn μ. The goal of the firm is to choose the two prices to maximize overall profit.

In this setting, given the pricing decisions of the firm, we analyze the buyers' adoption game, focusing on the Pareto dominant equilibrium that gives the highest utility to all concerned parties. A key ingredient of this game in our setting is the prior public belief about the average perception μ. Our analysis is guided by two main objectives. The first objective is to understand the impact of information about μ on buyers' equilibrium purchase decisions and consequently on the firm's profits. We show that for a fixed μ_0 and σ_0, depending on the value of σ, a firm may find it comparatively beneficial in terms of profit to either, a) fully alleviate the uncertainty about μ so that buyers can make informed adoption decisions, or b) induce the buyers to make their adoption decisions *blindly*, based only on the prior public belief. The former is the case when σ is small, which can be interpreted as the product being *niche* and catering to a population with relatively homogeneous preferences. The latter is the case when σ is large, which can be interpreted as the product having a mass appeal, catering to a population with widely varying preferences.

Our second objective is to address the question of operationalizing the public signaling of information when the firm itself is a priori unaware of μ, as is typically the case. We show how a firm can *orchestrate* such public signaling by appropriately designed discounts for early adoption. This strategy corresponds to a) providing a steep discount for early adoption in the case where it is beneficial to have the buyers make their adoption decisions blindly, and b) providing a vanishingly small discount for early adoption in the case where it is beneficial to have the buyers make their adoption decisions while being informed. In the first case, all adoption takes place in the early *blind* period, while in the latter case, *almost* all adoption takes place in the later *informed* period. Our technical analysis is accompanied by numerical analysis, which suggests that the better of these two strategies incurs negligible loss compared to the optimal promotional pricing strategy (which is difficult to characterize exactly but can be computed to an arbitrary precision).

*A draft of the full version of the paper is available at https://ssrn.com/abstract=3383676.

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