December 2000

# Information Complements, Substitutes, and Strategic Product Design

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# INFORMATION COMPLEMENTS, SUBSTITUTES, AND STRATEGIC PRODUCT DESIGN

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## Extended Abstract[1]

### 1. INTRODUCTION

In the information economy, competitive maneuvers have raised the question of when firms can increase profits by giving away free products Microsoft and Netscape (now part of AOL) competed by finding ever more channels through which to freely distribute their browser. Adobe widely distributes its portable document reader. Real Audio and Microsoft permit anyone to download their multimedia players. Sun Microsystems acquired Star, the most successful developer of a Linux office suite, in order to give its products away.

This paper presents an analysis and an answer to the free information question. Free strategic complements can raise profits for goods owned by the same firm. Our model predicts that firms may integrate or incur significant development costs in order to distribute portions of a pair of complements. In contrast, free strategic substitutes can lower profits for competitors inducing market exit when average cost curves are declining. Incumbents then benefit from reduced competition.

A firm can use strategic product design to penetrate a market that becomes competitive post-entry. The threat of entry is credible even in cases where the firm never recovers its sunk costs directly. In fact, a firm may use a complementary good to seek market share, not market power, and the loss from giving away free information can still be profit maximizing. This occurs if the free good either boosts sales of the firm's own complementary good or it thwarts sales of a competitor's substitute good, enough to offset losses from the investment subsidy. The key insight is that designing a separable product and under-pricing one component is a device for implementing price discrimination in markets with positive network externalities. The apparent contradiction of introducing and sustaining a product subsidy in one market resolves itself once it becomes clear how profits increase more than the subsidy cost in the other market. This undercuts the conventional wisdom that firms should seek to avoid Bertrand price competition. As in the case of the Internet browser wars, our framework illustrates how prices below marginal cost can be profit maximizing when they serve to stimulate demand across markets.

We note that the popularity of this product design strategy among information goods may in part be due to the unique properties of information. Because second-copy costs are negligible, a firm can afford to subsidize an arbitrarily large market while incurring a fixed initial investment cost. Each additional consumer of the free good costs the clever product designer nearly nothing in incremental costs. With increased consumption of information, we may expect to see increased use of the proposed

[1]The current version of the paper is available at http://faculty.freeman.tulane.edu/gparker/papers/InfoComplements.html.

product design strategy in the future. Correspondingly, this may help to explain the ubiquity of free information offered on the Internet.

## 2. MODEL FRAMEWORK

The mechanisms rely on fairly standard intuitions but, in fact, alter the standard models. We extend the idea of an intra-market network externality, or demand economy of scale, to an inter-market network externality, or simply an "inter-network" externality. We consider two markets for a given information product. The first is the general consumer market (subscript c). The second market is the joint-producer, developer, or content-creator market (subscript j). We model each consumer's willingness to pay as a function of the their own valuation and the number of consumers in the other market who buy.

The parameter Q bounds the quantity purchased while V bounds consumers' product valuations in the absence of externalities. The externality term $e_{jc}$ determines how much joint-producer purchases impact the consumer market. Conversely, $e_{cj}$ determines how much consumer purchases impact the joint-producer market. In order to work with linear demand curves, we assume that potential consumers in each market have a uniform distribution of valuations, but share their valuation of the externality from the alternate market. This yields the pair of simultaneous equations for quantity $q$ and price $p$:

$$q_c = Q_c + e_{jc} q_j - \frac{Q_c}{V_c} p_c$$

$$q_j = Q_j + e_{cj} q_c - \frac{Q_j}{V_j} p_j$$

Eliminating $q_i$ from the RHS leads to independent formulae:

$$q_c = \frac{Q_c + e_{jc} Q_j}{1 - e_{cj} e_{jc}} - \frac{Q_c p_c}{(1 - e_{cj} e_{jc}) V_c} - \frac{e_{jc} Q_j p_j}{(1 - e_{cj} e_{jc}) V_j}$$

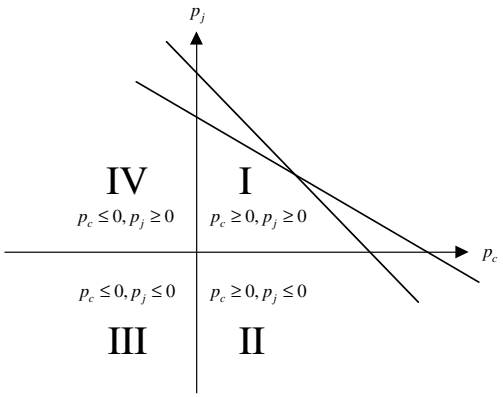
$$q_j = \frac{Q_j + e_{cj} Q_c}{1 - e_{cj} e_{jc}} - \frac{Q_j p_j}{(1 - e_{cj} e_{jc}) V_j} - \frac{e_{cj} Q_c p_c}{(1 - e_{cj} e_{jc}) V_c}$$

We require that $1 - e_{cj}\, e_{jc} > 0$ so that the network externality terms contribute only a finite and positive amount to consumer surplus. Taking first-order conditions, we can determine in which of four regions firms should choose to position their market offerings in order to maximize profit. The figure below shows each possible region, where the two lines are price constraints on each good that ensure quantities are non-negative.

Using this analysis, we identify distinct markets for content-providers and end-consumers and show that either can be a candidate for the free good. In the full paper, we also introduce tests to show which region is optimal.

The modeling contribution is distinct from tying or second degree price discrimination in the sense that consumers need never purchase both goods— unlike razors and blades, the products are standalone goods. It also differs from multi-market or third degree price discrimination in the sense that the firm may extract no consumer surplus from one of the two market segments, implying that this market would have traditionally gone unserved.

Although bundling zero marginal cost goods frequently represents a dominant strategy, the model can be generalized to show when unbundling dominates. Firms prefer to bundle when markets have similar values for different products or when network externality benefits are similar, even if they are large. Firms increasingly prefer unbundling as valuations and externality benefits diverge.




Four possible regions: (I) charge both consumers and joint-producers, (II) charge consumers, subsidize joint-producers, (III) subsidize both, (IV) subsidize consumers, charge joint-producers

**Figure 1. Four Market Regions**

Under various interpretations of externality terms $e_{jc}$ and $e_{cj}$ , the network complements model also helps to explain interesting market behaviors such as free novice and pricey professional versions (both are complementary), free introductory pricing (the early version complements the later version), tangible complements (as when free digital scripts and software improve expensive digital cameras), and strategic information substitutes ($e_{jc} < 0$ for a competitor as Java is for Windows). Thus the model helps to explain tradeoffs and provide profit maximizing guidance for firms providing free information.