Vaporware: Product Pre-Announcements in a Duopoly with Network Effects

Introduction

Pre-announcement of new products (still undergoing development) is an important practical and theoretical concern. While possible in any industry, it is particularly prominent in the IT markets, such as computer hardware and software. We specifically focus on announcements known as Vaporware – that is, products and services that are delivered after long delays or sometimes do not hit the market at all. A classic example is Ovation integrated software package, which was announced in 1983 but never delivered. Contemporary examples are in abundance, including Microsoft’s BizTalk, a game “Duke Nukem Forever” and Secure Digital Music Initiative. [1,2]. While it is not completely illegal, it is certainly anticompetitive; Software and Information Industry Association prohibits it in their principles of competition1.

The question of vaporware has got some attention in Marketing [3] and Industrial Economics [4], but not in the IS literature. The classic study of pre-announcements was done by Farrell and Saloner [5], but they focus on the pre-announcements of the truthful type. In our work, we fill this gap and explore reasons for existence of vaporware, providing the policy and managerial insights derived from a formal economic model. We also derive complimentary results regarding the social efficiency and strategic nature of pre-announcements overall. In the following sections, we present our base model, its analysis, model extensions and directions for future research.

Base model

We consider a case where there is an opportunity for the customers to adopt one of two competing and incompatible products. The model will look at the ability of the entrant firm to impact the division of the market by making an announcement of the product features before the product is available. The model will be described in terms of firms, consumers, timing of events and market clearance conditions.

Firms

Let there be two products, each produced by a separate firm. These products are serving the same target market, but they are not compatible with each other, so there are no cross-product network effects. Suppose that total production cost (fixed as well as marginal) is zero. Marginal cost may be considered to be zero if we work with information goods, which are known to have infinitely small reproduction costs. Fixed costs may be normalized to zero by arguing that they are implicitly included in the profits. Since there are two firms, they are either competing with each other in any given period (if both enter the market), or one is acting as a monopolist.

Consumers

We assume consumers to be infinitely small, so that they take market prices as given. Suppose there is infinite number of those, but they are distributed uniformly in the interval $X=[0,1]$. Then, the length of any sub-interval of $X$ represent the market share of some product (see Figure 1). We also assume that all consumers are acting rationally in self-interest, and that they are not able to coordinate their decisions with each other.

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1 http://www.siia.net/sharedcontent/govt/issues/compete/brief.html, see rule #8.
Suppose that all consumers have same basic valuation of any product, but they have different valuations between products. More specifically, let $x_i$ be the consumer demand for product $i$ ($i=1,2$). Then, we can write the general form utilities of these products to any consumer as:

$$U_1 = a + bx_1 \quad (1), \quad U_2 = c + dx_2 \quad (2),$$

where $a, b, c, d$ are all positive and $x_1, x_2$ are non-negative. This formulation implies that utility of any product to consumer is composed of two parts – a stand-alone utility that arises from the ability to use the product, and network effect resulting from others using the same product. For the base model, we assume that network effect is linear in demand; however, in the model extensions we show that it can be specified more generically as arbitrary functions $\nu(x_i)$.

We also assume that that product 2 is expected to be superior to product 1 either in stand-alone benefit ($c>a$) or network benefit ($d>b$); however, it is not available immediately.

**Timing of Events**

There are two time periods. In period 1, only product 1 is available, since product 2 will take time to develop. Also, the degree of its “superiority” is uncertain for all actors but firm 2, who undertakes R&D effort. Random variables $C$ and $D$ represent the possible value for the stand-alone and network value of product 2. We assume that, with probability $\omega$, there is no improvement in stand-alone benefit ($C=a$), and product 2 to is superior ($C=c>a$) with probability $1-\omega$. Similarly for the network benefit, $Pr(D=b)=\phi$ and $Pr(D=d>b)=1-\phi$. These probabilities are known to all market participants, but only firm 2 observes the realized values of $C$ and $D$.

Therefore, consumers know that a new product will be coming up, but they don’t know how good it will be compared to old one. Thus, possible strategies for the consumers are 1) adopt product 1 immediately; 2) wait and adopt product 1 later; or 3) wait and adopt product 2 later.

The interaction proceeds as follows:

1. Firm 2 learns the specific values of $C$ and $D$ for its product
2. Firm 2 decides whether or not to reveal the actual values of $C$ and $D$
3. Based on this information, consumers decide which product to buy and when
4. Based on consumer choices, firms set prices and act out monopolist or competition scenario in the two periods

**Market Clearance and Optimization**

We assume that all users buy some product eventually. In terms of consumer decisions described above, let us use the following notation:

$X_1$ – number of consumers adopting product 1 in period 1
$X_2$ – number of consumers adopting product 2 in period 2
\( X_3 \) – number of consumers adopting product 1 in period 2

Then, market clearance condition (graphically illustrated in Figure 1 above) implies that
\[ X_1 + X_2 + X_3 = 1 \]  
(3)

And the individual consumer’s decision problem is
\[ \text{Arg max } u(X_i), i = 1, 2, 3 \]  
(4),

with the individual utilities defined as following:
\[ U(X_1) = a + bX_1 + b(X_1 + X_3) \]  
(5)

\[ U(X_2) = E[C + DX_2] \]  
(6)

\[ U(X_3) = a + b(X_1 + X_3) \]  
(7)

Note that adopters in \( X_1 \) and \( X_3 \) group reap network-related benefit based on the size of the joint network. Also note the expectation of the benefits for product 2.

On the society level, we want to maximize total benefit to all consumers. Therefore, the problem of a social planner, if present, is a constrained maximization problem:
\[ \max W = \sum_{i=1}^{3} X_i u(X_i) \quad \text{subject to } X_1 + X_2 + X_3 = 1 \]  
(8)

(9)

Firms optimize their profit in a classical monopoly or duopoly setting. This completes the setup of the model; we dedicate the next section to the analysis of the model and its implications.

**Model Analysis**

In this section we present the main results of our model. While the core finding of this paper is on the analysis of the impact of false pre-announcements (vaporware), we also derive some complementary results regarding the overall effectiveness of pre-announcements in resolutions of uncertainty, their strategic nature and welfare implications.

To facilitate the analysis we simplify the solution space with the following lemma.

**Lemma 0.** Strategy of waiting to adopt Product 1 is weakly dominated and should be avoided by a rational consumer (i.e. \( X_3 = 0; X_1 + X_2 = 1 \)).

**Proof sketch.** Via analysis of consumer payoffs (All proofs omitted in the WISE version due to the space limitations)

Consequently, the rational strategy space for the consumers is covered by either adopting Product 1 immediately, or adopting Product 2 when it becomes available.

We prove the following claims that characterize the state of the market with pre-announcements:

\[ \int u(X_i)dx \]  
2 More formally, provided the continuous distribution of consumers, we would write max \[ \int u(X_i)dx \] , but since we are working with uniform distribution, this integral can be simplified to equation (8)
Theorem 1. (Welfare impact). Pre-announcements improve social welfare by resolving the uncertainty early. Full adoption of one of the products in socially optimal.

Theorem 2. (Strategic pre-announcements). Pre-announcements are a strategic tool that can be used to pre-empt the competitor from entering the market.

Theorem 3. (Existence and boundary conditions for vaporware). There exists a level of pre-announcement cost that is prohibitively high for vaporware, but still allowing truthful pre-announcements.

The reasons we present the results in this particular sequence are the following. On one hand, we show that pre-announcements increase social welfare and are, therefore, desirable. But on another hand, they can be used as an anti-competitive, predatory tool, thus calling for the need to control such activities in a certain way. Since false pre-announcements are particularly harmful, we need to explore the conditions which allow for truthful pre-announcements (to help efficiency) while blocking out the vaporware (used for anticompetitive reasons). Theorem 3 is a core contribution of this work, building on the results of Theorems 1 and 2.

While we will skip formal proofs due to space constraints, it is important to provide the intuition for the development of the results. To prove Theorem 1, we explore two conditions: first (simplified case) when the future parameters of Product 2 are known in advance to everyone, and second when there is an uncertainty about the magnitude of stand-alone effect.

In case when the parameters of Product 2 are known with certainty, the social welfare problem, after application of Lemma 0, may be restated as

\[
\text{Max } W = 2x_1(a+bx_1)+x_2(c+dx_2) \text{ s.t. } X_1+X_2=1
\]  

(10)

By analyzing the first and second order conditions of this problem, it may be shown that the maximum welfare cannot be achieved at an internal point of the interval \([0,1]\) in terms of the market shares of the products. Thus, once of the products should capture entire market (which one of the products is the winner is dependent on the composition of the parameters).

To show the positive role of the pre-announcement in resolving the uncertainty, we consider a more complex case where the extent of network benefit for Product 2 is certain while the standalone benefit is not known to consumers in advance.

Then, the consumer's choice is based on the comparison of the benefit of two products:

\[
a+2bx_1 \ \nabla \ E[C] +dx_2
\]  

(12), where \( \nabla \) is either \( >, < \) or \( = \).

After simplification, the choice condition becomes

\[
2bx_1-dx_2 \ \nabla (1-\omega)(c-a)
\]  

(13)

This equation tells us whether users would actually opt for the partial adoption of either product. But, as we have shown, any partial adoption results in welfare loss. Thus, it is socially beneficial if uncertainty is resolved early. This can be done only by pre-announcement.

Proof for Theorem 2 is a logical extension of the results of Theorem 1. If any firm emerges as a monopolist, it will be able to exercise its power with setting high prices; while in partial adoption scenario, there are incentives to engage in a Bertrand-type competition, which hurts both firms. So while a potential “loser” would be indifferent between such competition and being

\[3\] The reverse case, when the stand-alone benefit is certain and network benefit is uncertain produces logically equivalent results using very similar derivations. Therefore, we omit it for now.
locked out of the market, the “winner” has a clear incentive to resolve the situation early on, which is done using the pre-announcement.

To explore the strategies of pursuing the vaporware-type announcements vs. telling the truth, we consider the strategies of firm 2 depending on its type. Suppose that configuration of parameters $a$, $b$, $c$, $d$ is such that firm of type $C=c$ (high type) has a clear advantage over firm 1, and firm of type $C=a$ (low type) has a clear disadvantage, under conditions of certainty. (Other configurations will lead to trivial results based on (13)).

Observe that, for $\omega \in (0,1)$: $a < \omega a + (1-\omega)c < c$. (14)

The inequality above essentially states that value of uncertainty is less than the value of certainty for the high type, but the opposite is true for the low type. Therefore, high type $C=c$ will always pre-announce her product, to “win” the market and avoid even the slightest chance of confusion and going into Bertrand competition.

Situation of low type $C=a$ is more complicated. First of all, pre-announcement of $C=a$ does not help, since it will result in losing the market with certainty. Second, trying to hide its type by making no-preannouncement at all is not helpful either, as both consumers and firm 1 will know from lack of announcement that firm 2 is of low type. Thus, the only solution for firm 2 is to pretend to be of high type.

This brings up the question of cost of pre-announcement of false type. If firm 2 of low type actually wins the market, it makes profits $\pi_2 = X_2^*(a+dX_2)=a+d$. Thus, it will be willing to pay any amount $R < a+d$ to send the signal that it is of type $C=c$. We will have a pooling equilibrium, where both types do the pre-announcement of type $C=c$. The difference is, in case of high type, it is truthful, but in case of low type, it is what we know as “vaporware” – announcing a product with features that the firm knows it cannot deliver.

Existence of vaporware depends on the magnitude of $R$. If it is greater than $a+d$, but less than $c+d$, then it is not beneficial for a firm 2 of low type to do the preannouncement, but high type still wants to do it. We have a separating equilibrium, where vaporware does not exist.

Unfortunately, in the real world, cost of “getting the word out” is rather low, therefore vaporware is quite common in practice.

**Extensions**

At this time, we have developed two extensions to the model.

a) **Uncertainty in other parameters**

Above we presented the analysis in case when the uncertainty is over the degree of stand-alone benefit of products 2. The analysis extends very similarly to cases when uncertainty is over the magnitude of network effect, or even the case when both of these parameters are uncertain. However, conceptually the derivations are not too different, and the fundamental decision rule by end users remains the same.

b) **Non-linear form of network effects**

Our analysis also extends to other functional forms of network effects. Suppose, for example, that the form of user’s utilities from products is:

$$U_1 = a + v_1(x_1) \quad (1a), \quad U_2 = c + v_2(x_2) \quad (2a),$$
Where $v_1, v_2$ are arbitrary functions with the following properties:

- $v_i(0) = 0$, $v_i(x > 0) > 0$ (network effects are positive)
- $v_i(x)$ is continuous and twice differentiable
- they are monotonically increasing ($v_i'(x) > 0$)

With the similar analysis we show that for all network effect functions that exhibit increasing or constant returns to scale, our analysis holds true. Furthermore, it will also hold for some decreasing returns to scale functions. Thus, our approach is generally applicable to a large class of problems.

**Discussion and Future Work**

We present a model of new product pre-announcements by an entrant to an industry in a duopoly setting with network effects. We show robustness of the model to multiple levels of uncertainty in product utilities (including both stand-alone and network effect value), as well as to several types of functional forms for network effects.

There are three important results generated by this model, which have policy as well as managerial implications: 1) Pre-announcements may increase social welfare by reducing uncertainty leading to inefficient adoption of products; 2) Due to network effects, pre-announcements are very likely to assist in formation of monopolistic markets; 3) Sufficiently high cost of making the pre-announcements will lead to extinction of vaporware.

Our results call for a flexible evaluation of pre-announcements on the part of policy makers and legislators, as pre-announcements can be increasing efficiency of markets along with giving rise to anti-competitive behavior.

The main analytical work is complete and full results are ready to be presented at WISE. Potential extensions include analysis of inherent uncertainty in R&D outcomes, more complex consumer behavior and the impact of vaporware on consumer trust and reputation.

**References**