E-COMMERCE MODEL DYNAMICS

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ABSTRACT

E-commerce is a dynamic, quickly changing phenomenon. This implies that e-commerce firms are constantly evolving from one model to another very rapidly. There would be many ways to explain the dynamics of e-commerce models, including economics, configuration, and maturity. This paper presents an economic model to explain the adoption, growth, and withdrawal process of a new business model.

Keywords: e-commerce, business model dynamics, economic model, firm efficiency

INTRODUCTION

E-commerce is classified by its model varieties (12), but such taxonomy is a static representation because e-commerce is a dynamic, quickly changing phenomenon (10). E-commerce firms are constantly evolving from one model to another very rapidly. They strive to exploit business opportunities by changing business models rapidly but often without solid justification. Then what are the underlying reasons for e-commerce model dynamics? We could explain such phenomenon in terms of three business aspects: economics, configuration, and maturity.

Since the advance of the Internet-based e-commerce in the late 1990s, we have witnessed many "dotcoms" running out of funds due to non-materialization of profits, and as a result they have yielded themselves to rivals or stopped doing business online (11). They have failed dismally in their attempt to maximize or even realize their profits, which is one of the most critical factors for firms to be remained as going concerns. As a consequence, the e-commerce firms on the brink of a failure have been trying to discover new revenue sources. One of the direct results of the struggle is to "invent and try" new business models with the hope of avoiding a worst situation (5). As for the configuration aspect, e-commerce firms do not have the same overhead costs as conventional firms. Unlike e-retailers, retailers may need substantial overhead costs to change their business models (9). Another explanation could be a characteristic of the Internet as an almost infinite and cheap printing press. It makes it very easy for e-commerce firms to establish a new storefront at a negligible variable cost (3). By contrast, it is also easy for them to withdraw their current offerings. Even though adding or removing a storefront could be costly, this degree of flexibility is very unlikely in the case of conventional firms (4, 6).

Yet another explanation is related to the degree of maturity of e-commerce, that is, the development stage of e-commerce. It is still in its infancy in terms of total e-tail sales. According to the US Census Bureau (http://www.census.gov/mrts /www/current.html), total e-tail sales for the 4th quarter of 2001 were about \$10 billion, while total retail sales for the same period were about \$860 billion. When a business sector is in its infancy, firms in this stage are trying to grab a large market share by increasing revenue at the expense of short-term loss. When firms are uncertain about the demand curve they actually face or when they have no reliable notion of the marginal costs of their product (as may be especially true in multi-product firms), the decision to maximize sales may be a reasonable rule of thumb for assuring their long-term survival (1). In the area of e-commerce, many firms have cash to "burn out" during the short-term loss (11). Despite the seemingly apparent reasons, the following question appears to be worth attention: what kind of economic formalization can explain the e-commerce model dynamics? The answer should be important because it can provide a meaningful decision criterion on which the active managers of e-commerce firms can adopt a "valid-and-justified" business model instead of a mere "trial-and-error" business model. Little, however, is understood about the dynamics of e-commerce models.

To explain the dynamics, we propose a model of "dynamic" selection of e-commerce models. An efficient firm in implementing a new business model grows and survives and so does the business model; an inefficient firm declines and fails, so does its new business model. When the stock market does not reflect the true value of e-commerce firms, they differ in size not because of the market capitalization but because of the level of efficiency. The model provides an explanation for adoption, growth, and withdrawal process of a new business model that agrees with certain evidence. The next section briefly describes the model followed by the details of the model and the withdrawal decision. The paper concludes with some implications and suggestions for future research.

INTRODUCTION TO THE MODEL

The model deals with e-commerce firms to which products they will sell through a change in their business models are supplied at a constant price. The product is homogeneous and the overall demand for the product is predictable. Costs incurred by adopting a new business model are random and different among firms. For each firm, the mean of its costs may be thought of as the model's "true cost." The distribution of true costs among the potential competitors is known to all, but no firm knows what its true cost is. All incumbent and potential firms have the same prior beliefs about their true costs incurred by the new business model, and each firm regards itself as a random draw from the population distribution of true costs. This "prior" distribution is then updated as evidence comes in. If the new business model has low true costs, it is likely that the evidence will be favorable, and the business model will survive. If its costs are high and evidence adverse, the business model may not wait too long before withdrawing from the e-commerce firm.

The number of firms, including existing offline and online as well as potential ones, is infinite—each firm is too small to affect price. This means an "online-only" e-commerce firm should consider existing online and offline competitors as well as potential entrants. It is important to take potential competitors into account because, unlike the conventional channel, the Internet manifests relatively low barriers to entry and imitation (7). This implies that e-commerce firms are essentially price takers. However, as we can witness in the real world of e-commerce, some firms may act as price setters in the very short term because the non-equilibrium prices will shortly be known to competitors and customers because of the very nature of the Internet (2). The power of price manipulation may come from various sources, including first mover advantage, higher acceptance, and existing customer base—that is, different levels of efficiency among firms. With uncertainty at the individual level but with no aggregate uncertainty, the path of product price is deterministic and is assumed to be self-fulfilling in equilibrium. In other words, the product price keeps moving toward an equilibrium price at which aggregate supply and demand curves cross each other. Incumbents and potential entrants know the entire equilibrium price sequence, and based on it, they adopt a new business model, implement it, and make withdrawal decisions. A one-time adoption cost of a new business model is borne at the time of the adoption. Therefore, only implementation costs of the new business model are incurred. In equilibrium, the net present value of a new business model cannot be positive. If it were, more firms would enter into the new business model.

In the next section, the model is presented, and the firm's optimization problem is defined. Some of the properties of the model then become clear. Figure 1 portrays them concisely: efficient firms in implementing a new business model grow, and hence the business model survives; the inefficient decline and fail.

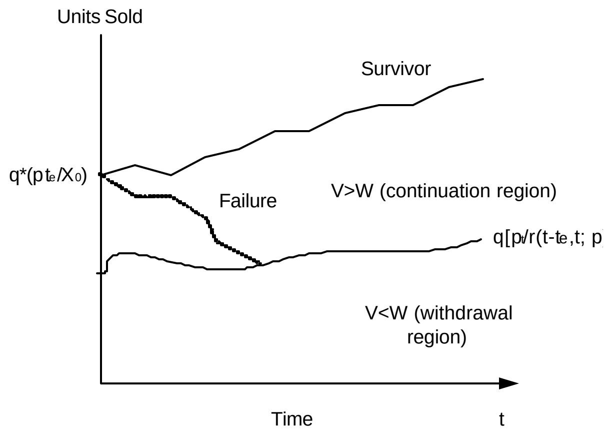

Figure 1. Continuation and withdrawal regions. V denotes the value, at t, of staying in a new business model and W denotes the expected present value of the firm's intangible asset that would return if they were invested in other activity.

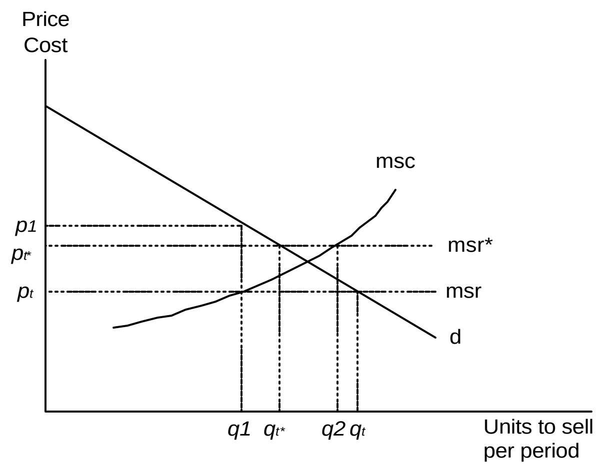

Figure 2a. An increasing marginal sales cost firm.

THE MODEL

In an e-commerce sector selling a homogeneous product, firms differ in efficiency. Some are more efficient than others at all levels of sales regardless of the number of transactions over time. Let q be the number of units of the product sold. It may be a tangible like a TV set or an intangible like an auction, which has been added by adopting a new business model. Let $c(q)$ be a cost function which satisfies c(0) = 0 and $c'(q) > 0$. Total costs, which are associated with selling a new product by adopting a new business model, are $c(q_t)x_t$ where x_t is a random variable independent across e-commerce firms, and where t is a given time. For the firm of type F (i.e., a firm with various inefficiencies such as inefficient shipping and handling or inefficient supply chain; F is often converted as a monetary term), let $x_t = f(h_t)$ where $f(.)$ is a positive, strictly increasing function, and where $h_t \approx F + e_t$, $e_t \sim N(0, d^2)$ iid (independent and identically distributed). Firms with large values of F will generate larger x_t's, and be less efficient at all levels of sales. The e_t are firm specific factors (e.g., management inability), which are independent over time and across firms. Among potential firms, F (i.e., converted as monetary term) is normally distributed with mean $\overline{\Phi}$ and variance d^2_{Φ}. An entrant does not know its own$F$, but it knows that it is a random draw from $N(\overline{\Phi}, d^2_{\Phi})$. The entrant also knows the variance of e_t, as well as the exact form of $f(.)$ so that observing its own costs at t allows it to infer h_t. As mentioned previously, the number of firms selling a homogeneous product is assumed to be infinite. However, depending on the true costs, the firm may be able to affect price. Based on this, we can think of three different cost structures resulting from the level of efficiency of a firm. They are shown in three figures (Figure 2a, 2b, and 2c). Figure 2a shows an increasing marginal sales cost (msc) firm.

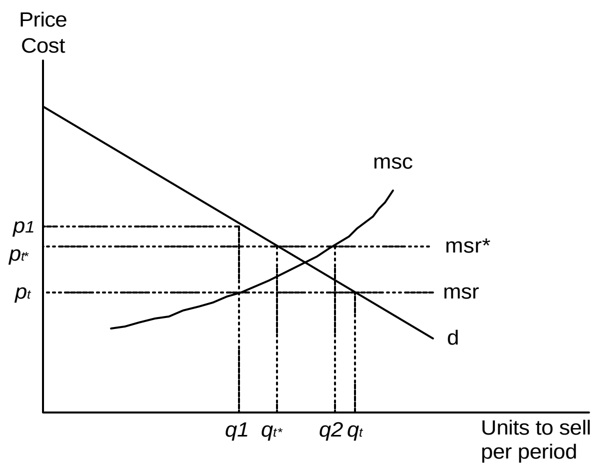

Figure 2a. An increasing marginal sales cost firm.

The marginal sales revenue (msr) is equal to the market prevailing price. If a market prevailing price is equal to p_t at time t, then the firm can maximize its profit by selling q_1 and its revenue at q_t. The firm cannot sell more than q_t because of the demand curve the firm faces. Depending on the firm's goal, it can sell at prices higher than p_t. If the firm's goal is to maximize its profit, the firm will have the pricing leeway between p_t and p_1. If the firm's goal is moving toward the revenue maximization, the gap will become less and less. If the firm's goal is maximizing revenue, then it should take the market price. It is quite possible for the firm to lower the price below the market price to grab larger market share. This kind of action, however, will eventually end up with going out of business unless the firm has a very "deep pocket." Prices higher than the market prevailing price (p_t) will not last long because the firm's demand curve will eventually move inward. If the firm can move the "msc" curve outward by lowering true costs, the firm will be able to sell more while maximizing profit. Ironically, the gap between p_t and p_1 is getting smaller as the firm sells more at p_t. Similarly, if the prevailing market price is p_t^*, the firm can maximize its profit at q_2 but, due to its demand constraint, it can only sell q_t^*. It becomes a price taker and enjoys some profit while maximizing revenue. This means that the firm cannot maximize its profit. Instead, the firm will have some freedom in adjusting its total costs (e.g., can provide more costly service) while sacrificing sales units but maximizing profit at a higher cost. It implies that to sell a high-priced item, more costly service is required to maximize profit. According to this model, both the price and cost "freedom" are also affected by the price elasticity of demand. The more price elastic, the more the cost freedom is, but the less the price freedom is. Figure 2b is about a firm that has a decreasing marginal sales cost.

This case is relatively simple. The firm may maximize its profit by selling q_2 and q_1 at prices at p_t^* and p_t, respectively. Alternatively, the firm can maximize its revenue at q_t and q_t^* depending on the prevailing market price. If the firm sets its goal of profit maximization, it will have a pricing power between p_t and p_2 depending on the prevailing market price. If the firm tries to win a larger market share beyond q_t and q_t^*, it may lower its price to the point where "msr" meets the lowest point of "msc" or even further if the firm can tolerate the loss. The price elasticity of the demand only affects the magnitude of pricing freedom.

Figure 2c describes a firm that has first decreasing and then increasing marginal sales cost. If a firm faces this type of "msc," it can maximize its profit at q_1 or q_2 depending on the prevailing market price. But q_2 is beyond the demand curve, so they should sell q_t^* while maximizing revenue at the price of p_t^*. Regardless of the prevailing price p_t or p_t^*, however, the firm can still grab a larger market share while maximizing revenue at the lowest point of its "msc" curve. The firm hence will try to lower its price to p_q or even further depending on the available cash.

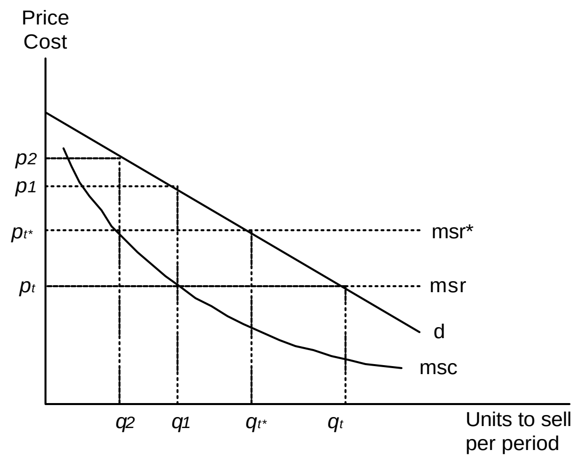

Figure 2b. A decreasing marginal sales cost firm.

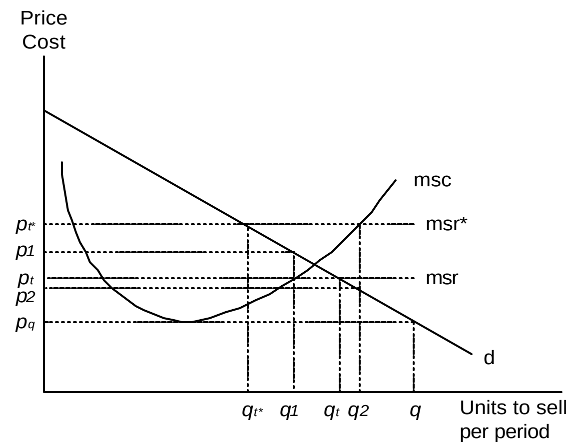

Figure 2c. A firm with decreasing and then increasing marginal sales cost.

In general, if a firm seeks to maximize profit by choosing q_{tp} at the price of p_{tp} , it can be formally represented: max $[p_{tp}q_{tp} - c(q_{tp})x_t^*]$ where x_t^* is the expectation of x_t conditional upon information received prior to t. The decision on the number of units to sell is made before x_t is observed and is denoted by $q(p_{tp}/x_t*)$. As we have seen in the previous three cases, it is decreasing in x, and $\partial q/\partial x_t^* < 0$. The "msc" curve is determined by a new business model's cost distribution—that is, $c(q_{tp})x_t$. The demand curve is given. The price elasticity greater than –1 implies a negative "msc"—an obvious impossibility. Hence, profit-maximizing firms will only choose to sell at points on the demand curves they face where demand is elastic. If a firm tries to achieve revenue maximization, it can choose q_{tr} at the price of p_{tr}, it can be formally represented conditional upon its cost distribution: max $[p_{tr}q_{tr}]$. If demand is elastic, the sale of one more unit will not affect price "unduly," and hence more revenue will be generated by the sale. This means that shifting the "msc" curve outward (i.e., reducing marginal sales cost) is critical to increase revenue. If demand is inelastic, increases in the number of units to sell can be obtained only through "large" declines in market price, and these declines will actually cause total revenue to decrease.

We have described the three possible scenarios. The major factors that determine the number of units for a firm to sell are its marginal sales cost, the prevailing market price, and its goal. If we assume the prevailing market price is stable or even constant for a given period, and that the firm's goal is to maximize either profit or revenue, the most important factor that decides a firm's behavior in terms of its business model is the firm's marginal sales cost, which is in turn determined by its true cost distribution. To repeat, costs incurred by adopting the new business model are random and different among firms. For each firm, the mean of its costs may be thought of as the model's "true cost." The distribution of true costs among the potential competitors is known to all, but no firm knows what its true costs are. All incumbent and potential firms have the same prior beliefs about their true costs incurred by the new business model, and each firm regards itself as a random draw from the population distribution of true costs. This "prior" distribution is then updated as evidence comes in.

THE WITHDRAWAL DECISION

Let $W > 0$ be the expected present value of the firm's fixed intangible asset (e.g., higher awareness) if it is employed in a different activity instead of adopting a new business model. Regardless of the equality of W across firms selling the homogeneous product, what really matters is that if favorable information about a firm's costs in a new business model raises its expected earnings in the new business model by one dollar, its expected earnings elsewhere increase by less than a dollar. In other words, if the prior distribution of a firm's true costs estimated during an early adoption process proves to be favorable as evidence comes in, the firm will enter the new business model.

A cost of entry, k, is borne by the firm when it enters—the cost of establishing a particular storefront and extending warehousing capacity for example. And F (i.e., measurable inefficiency) might be any inefficiency of the entry process. The firm learns about F with the passage of time. The firm has an infinite horizon and a constant discount rate r. At time t, if the firm is in the e-commerce area, it has a pair of statistics ($\bar{h}_n$, n) which characterize its beliefs about its F. Here n is the number of periods that the firm has been in the new business model (the age of the firm). These two statistics are sufficient for the posterior distribution on F. In spite of the infinite horizon and the constant discount rate, the present value of earnings will depend on t too, because the price path treated as given by the firm (i.e., no influence on the market price), is in general not constant (as we mentioned earlier due to the pricing power). Therefore, once the price path is given, t determines where one is along the price adjustment sequence.

Let $p_p(p_t, x) \equiv p_t q(p_t/x) - c[q(p_t/x)]x$ be the expected value of profits maximized with respect to q when $x_t^* = x$. Similarly, let $p_r(p_t, x) \equiv p_t q(p_t/x)/c[q(p_t/x)]x$ be the expected value of revenue maximized with respect to q and total costs when $x_t^* = x$. Let $V(x, n, t; p)$ be the value, at t, of staying in the new business model for one period and then behaving optimally (i.e., optimal decision on continuity or withdrawal). Then V satisfies

$V(x, n, t; p) \approx p_p(p_t, x) + b \int \max\,[W, V(z, n+1, t+1; p_{t+1})]$ under the probability that $x_{t+1}^* \leq$ z given that x_t^* = x, and given the firm has been in e-commerce for n periods. This basically means that a firm's value of staying in the new business model roughly equals the profits at time t plus the biggest gain or loss at the next time period when the next period's x is less than or equal to its distribution's mean—that is, when the evidence about the true costs is favorable. b is the coefficient that is used to reflect certain unexpected event that has affected W or V abnormally (e.g., slowly growing online time). In a similar manner, we can define the relationship between V and $p_r(p_t, x)$.

At entry, when the firm has only its prior information, $x = x_0 \equiv$ prior mean of x_t, and $V(x_0$, 0, t; p), then minus k is the net value of entry at t. Thus firms with higher expected costs have a lower value of staying in the new business model. Let $\gamma(n, t; p)$ be the level of x_t^* at which the firm is indifferent between staying in the new business model and leaving it, then $\gamma(.)$ is the solution for x to $V(x, n, t; p) = W$. As V is strictly decreasing in x, $\gamma(.)$ is uniquely defined. Consequently the number of units below which the firm will withdraw from a new business model is $q[p_t/\gamma(n, t; p)]$. This is shown in Figure 1. Here t_e is the time at which the firm enters the new business model, so $n = t - t_e$. For any price sequence, the boundary defines a "withdrawal" region in which $V \leq W$ and a "continuation" region, in which $V \geq W$.

In summary, e-commerce firms may have various true costs. They enter a new business model with the prior distribution of true costs, not with the actual distribution of true costs. They collect evidence about their true costs with the passage of time. Some firms may have favorable evidence and some may not. While collecting evidence and updating their true cost distributions, they decide the number of units to sell. It may be located either over or below the boundary. Depending on the region, they will decide whether or not they should continue the new business model.

CONCLUSION AND FUTURE RESEARCH

According to the model presented above, e-commerce firms will have their own locus of business models. An e-commerce firm who does not expand or divest but changes selling tactics, target markets, and even the product or service quality until it gets fixed while going through a rough patch would be in the withdrawal region with a hope things are getting well sometime. A firm who keeps looking for moneymaking business through a cycle of investment and divestment while maintaining a core business would be around the boundary. A firm who diversifies by entering into business not in the same chain of operation via either a concentric diversification or a conglomerate diversification (8) would be in the continuation regions or at least it believes it is. Finally, a firm who tries to find out its niche market by purging some redundancies might be in withdrawal region or on the boundary. Although the presented model explains many aspects of the dynamics of e-commerce models, it needs to be backed by more sophisticated observations and empirical tests.

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