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# STRATEGIC GROWTH OF FIRMS IN THE DIGITAL ECONOMY: SIMULATION AND RESEARCH PROPOSAL

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## Abstract

*With the rise of the Internet as an important dimension of business, fierce competition is resulting in industries that fit skew distributions, where those few firms that can best leverage the digital economy accrue the majority of the revenues. Porter points out that the Internet erodes industrial profitability and intensifies the need for sound strategy. As a tool for modeling the growth of firms in the competitive Internet environment, we apply Herbert Simon's model for business firm growth and relate its two key parameters—rate of entry and industrial growth potential—to Porter's strategic theories. We also introduce the idea of individual growth potential as a measure of firm competitiveness within an industry. We present a research proposal to empirically test the model, and provide the results from a simulation to demonstrate the applicability and usefulness of Simon's model to the business environment in the digital economy.*

## 1 INTRODUCTION

In the rapidly changing digital economy, the cycle of winning and losing and asset redistribution intensifies as the speed of information exchange increases. As a result, the size and performance of business firms increasingly resembles a one-sided skew distribution. A few businesses, such as eBay and Amazon, dominate the market while a large number of smaller companies struggle to survive. It is more necessary than ever to find explanatory theories to describe, model, and predict the emerging market structures of the digital economy, both at the aggregate level of industries, and for individual firm competition (Clemons et al. 2001).

In the 1980s, Michael Porter (1980, 1985) developed theories of industry profitability and individual firm competitive advantage. More recently, Porter (2001) applied his theories directly to the Internet's effects on competitive strategy. To further assist managers in the Internet age, concrete quantitative theories are also helpful for better understanding the dynamics of business growth and competition in the digital economy. Herbert Simon, the 1978 Nobel laureate in economics, developed such a model (Ijiri and Simon 1964; Simon 1955; Simon and Bonini 1958). Designed for modeling the growth of business firms in industries with skew distributions, Simon's model provides a timely solution to the present need for a quantitative theory to enhance the usefulness of Porter's strategic theories for effective strategic application in the Internet age.

This study applies Porter's strategic theories and Simon's model for business firm growth as theory-grounded solutions to help managers understand the competitive dynamics of the digital economy. We present a research proposal with a simulation of the

growth of firms in the Internet age, and explain how we can use actual empirical data to relate the parameters of Simon's model to strategic variables that can give managers a valuable strategic tool to understand the context of their industrial competition in the digital economy.

## 2 PORTER'S STRATEGIC THEORIES AND SIMON'S SKEW DISTRIBUTION MODEL

### 2.1 Porter's Analysis of the Internet's Effects on Strategy

In Porter's (2001) examination of the Internet's effects on strategy, he found that the Internet hurts industrial profitability and intensifies the ferocity of competition. Using his five-forces model (Porter 1980) as a framework, he detailed several ways that the Internet decreases average industry profits. However, Porter argued that this situation means that companies need to emphasize careful strategizing more than ever. A firm in the Internet age can compete effectively only by strategically positioning itself with a sustainably unique value proposition that gives it a cost or price advantage (Porter 1996).

Although Porter's (1980; 1985) theories of competitive strategy have been widely cited and applied, we have found few scholarly attempts to quantify the important dimensions of these theories (one exception is Corbett and Karmarkar 2001). Such quantification would permit industries to be compared for their average profitability based on the structural dimensions of the five-forces model, and would permit an objective comparison of the competitiveness of firms within the same industry.

### 2.2 Simon's Skew Distribution Model for the Growth of Business Firms

A skew distribution occurs whenever a few significant items or members of a set are responsible for a significant majority of the productivity, while the majority of items or members are responsible for only a relatively small portion. The classic skew distribution is the Pareto "80-20 principle" where approximately 80 percent of national income or wealth accrues to 20 percent of the population. After comparing several mathematical representations of skew distributions (Chen and Chong 2000), the most promising we found has been that developed by Herbert Simon for modeling the growth of business firms using skew distributions (Ijiri and Simon 1964; Simon 1955; Simon and Bonini 1958). Simon's model has been employed to some degree in the economics literature (Evans 1987; McCloughlan 1995; Sutton 1997). In our case, it provides a timely solution to the present need for a quantitative theory to enhance the usefulness of Porter's strategic theories for effective strategic application in the Internet age.

Simon (Ijiri and Simon 1964) presents a stochastic model that describes a number of firms in an industry. In each time period, the industry as a whole experiences a unit of growth, arising either from the entry of a new firm into the industry (and into the pool of firms being modeled), or from the unit growth of a single firm in the industry.  $\alpha$  designates the *rate of new entry* into the industry, expressed as a number from 0 to 1, indicating the probability that the unit growth of the industry in a given time period goes to a new entrant. (The model makes the simplifying assumption that  $\alpha$  actually represents the *net* rate of new entry, thus accounting for industry entries and exits.)

If in a particular time period the industry grows by the enlargement of an existing firm rather than by the addition of a new one, the probability of any existing firm experiencing this growth is a weighted average of  $1-\alpha$ . The weight of each individual firm depends on how recently it experienced growth. The assumption here is that a firm that has experienced recent growth is more likely to grow again in the present than is another firm that experienced growth a relatively long time ago. The strength of this industry recency effect, or *growth potential*, is measured by a number  $\gamma$  between 0 and 1. In an industry with  $\gamma = 0$ , neither current size nor past growth give any advantage in current growth. In an industry with  $\gamma = 1$ , current growth is entirely dependent on current size, with no regard to recency of growth (Watson et al. 1999); that is, the larger the firm at present, the greater its chances to grow in the immediate future. Simon estimates that most  $\gamma$  values would be between 0.9 and 1, for which recency of growth has a greater effect on current growth than does the current size of a firm.

Mathematically, Simon's model expresses the probability  $P$  that a particular firm  $i$  will grow by one unit in the  $(k + 1)$ <sup>st</sup> interval as

$$P[y_i(k + 1) = 1] = \frac{1}{W_k} \sum_{\tau=1}^k y_i(\tau) \gamma^{k-\tau}$$

where  $k$  is the current time period;  
 $y_i(\tau)$  is 1 if firm  $i$  grew by a unit in time  $\tau$ , and 0 if not;  
 $\gamma$  is the industry growth potential; and  
 $W_k$  is the sum of growth potentials of all firms, described in Ijiri and Simon (1964).

## 2.3 Strategic Implications from Simon's Model

The barriers to entry are one of the five forces that affect the profitability of an industry (Porter 1980). When barriers to entry are reduced, its inverse— $\alpha$ , the rate of new entry in Simon's model—is correspondingly increased.  $\gamma$  represents the strength of this growth potential or recency effect. It is unclear at this point of our research what more familiar strategic variables  $\gamma$  might represent. It does seem, however, that  $\gamma$  is similar to the concept of network effects (Achrol and Kotler 1999). Porter (2001) discussed the effect of the Internet in creating network effects, conceding, "Where such effects are significant, they can create demand-side economies of scale and raise barriers to entry" (p. 68). However, he further argues that in order to raise entry barriers, network effects must be proprietary, and even then, they are subject to diminishing returns after they have saturated their target market. Thus,  $\gamma$  is not a parameter that reflects an advantage proprietary to any individual firm; it would be the strength of network effects that operate throughout the entire industry from the efficiency and information intensity that the Internet has brought about.

In a sense, Simon's model as originally presented is nonstrategic. It is a stochastic model that tries to model the general pattern of the growth of firms within an industry. Although it does track the growth of individual firms, with some outperforming others, the determination of which particular firm would outperform another is entirely determined by chance. However, by tracing the pattern of each individual firm's growth, each firm could be assigned its own growth potential. From this approach, we propose an individual growth potential,  $\gamma_i$ , a parametric form of the industry growth potential,  $\gamma$ , where each firm  $i$  has its own individual  $\gamma_i$ .

$\gamma_i$  corresponds most closely to the concept of sustained competitive advantage, the ultimate goal of strategy (Porter 1985). Porter (2001) argues that the Internet can effectively increase a firm's competitive advantage only when the firm appropriately positions itself by aligning its strategy to use the Internet to maximum benefit, observing the six fundamental principles of strategic positioning (Porter 1996): right goal, value proposition, distinctive value chain, trade-offs, fit, and continuity.

## 3 RESEARCH PROPOSAL AND SIMULATION: EMPIRICALLY TESTING THE MODEL

### 3.1 Data Collection for Proposed Study and Description of Present Simulation

The Brookings Institution identified a number of industries significantly impacted by the Internet: manufacturing, automotive, financial services, trucking, retail, and health care (Litan and Rivlin 2001). We will gather actual firm-size data from these sectors for our proposed study. We will use both generic size measures (such as gross or net revenues, profits, and gross assets) and industry-specific measures (such as number of automobiles sold in the automobile industry). Our data sources would most likely be a triangulated mix of public sources, such as the European Union information database and the United States Economic Census, and proprietary sources, such as the Economist Intelligence Unit or Forrester Research.

Our simulation of a skew-distributed industry for the present study demonstrates Simon's model graphically, and it gives us a more concrete basis to discuss how to relate the parameters of Simon's model to Porter's strategic variables. Ijiri and Simon (1964) describe the details of the procedure. For this study, we simulated the growth pattern of 250 firms in 1,234 periods of unit growth, with  $\alpha = 0.2$  and  $\gamma = 0.95$ .

### 3.2 Results of the Simulation with Comments on Proposed Study

#### 3.2.1 Industry Level Data

For an industry perspective on the growth of business firms under the effects of the Internet, we will plot the percentage cumulative number of firms on the horizontal axis, and the percentage cumulative assets on the vertical axis. In our simulation, 74.2 percent of the assets reside in 26.0 percent of the firms (this point is circled in Figure 1). This demonstrates that our simulation is a good representation of phenomena that manifest a Pareto 80-20 skew distribution.

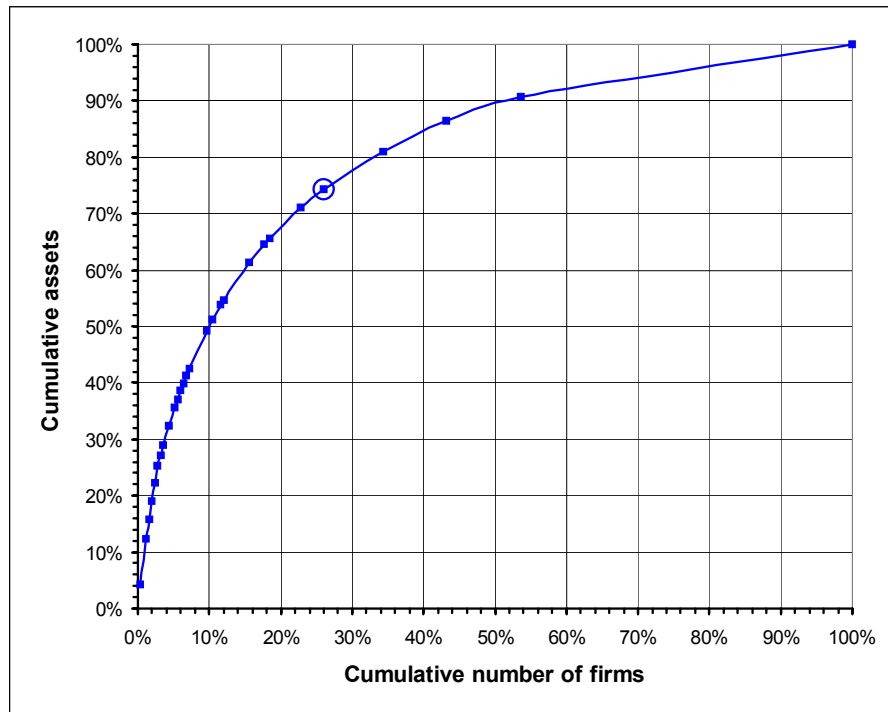


Figure 1. Skewed Distribution of Simulated Industry

To use the plotted data to determine the industry values of  $\alpha$  and  $\gamma$ , we must fit the actual data to the model to derive these parameters. To determine  $\alpha$ , we could simply divide the total number of firms by the total number of units of growth at the end of the observation period, or we could try to estimate a dynamic functional form that represents the rate of entry at any given point in time. For this calculation, we would need to take into account the theoretical determinants of barriers to entry (Porter 1980). Computing  $\gamma$  would involve observing the state of the industry at each point in time, dynamically calculating the value of  $\gamma$  at each point, then obtaining an average value that is representative of all the time periods. While the concept of  $\alpha$  (rate of entry into the industry) is relatively simple,  $\gamma$  is a complex, rich parameter that can capture network effects as an aspect of the attractiveness or profitability of different industries.

### 3.2.2 Growth Charts for Individual Firms

For competitive strategy, we need to observe the individual performance of each firm. Table 1 traces the growth patterns of the 18 largest firms. The numbers under the periods indicate the cumulative amount of growth the particular firm experienced by the end of the indicated period. Each of the firms experienced growth that ranged from 100 to 500 periods. While this is an imperfect approximation of reality in process, the end result of our simulation corresponds closely with what we would expect: We find that only three of the first 10 firms (the early movers) made it to the top 18. While four of the firms that ended up in the top 10 (the 1<sup>st</sup>, 2<sup>nd</sup>, 21<sup>st</sup>, and 49<sup>th</sup>) were among the first 50 entrants, the top firm at the end of the simulation was the 180<sup>th</sup> entrant, and the 201<sup>st</sup> entrant tied with the 1<sup>st</sup> entrant for second place.

To compute individual competitive advantage from our actual data, we will follow a backward derivation procedure similar to what we describe for calculating  $\gamma$  above. However, rather than aggregating the results and calculating an industry-wide  $\gamma$ , we will compute an individual  $\gamma_i$  for each firm.  $\gamma_i$  seems to represent an index of individual competitive advantage in comparison with the other firms in the industry. Such an index would be valuable when evaluated against Porter’s (1996) principles of strategic positioning.

**Table 1. Growth Pattern of 18 Largest Firms in a Simulated Industry of 250 Firms**

Entry order	Period ending at time:													Rank order of size
	100	200	300	400	500	600	700	800	900	1000	1100	1200	1234	
1	36	50	50	50	50	50	50	50	50	50	50	50	50	2
2	21	21	21	21	21	21	21	21	21	21	21	21	21	10
8	4	19	19	19	19	19	19	19	19	19	19	19	19	14
21	3	14	17	20	36	36	36	36	36	36	36	36	36	7
49		1	33	42	42	42	42	42	42	42	42	42	42	4
51			21	21	21	21	21	21	21	21	21	21	21	10
87				7	18	18	18	18	18	18	18	18	18	15
91				1	5	14	19	24	24	24	24	24	24	8
93				2	15	20	22	22	22	22	22	22	22	9
100					5	19	20	20	20	20	20	20	20	12
126						8	20	38	40	40	40	40	40	6
131						1	14	17	17	17	17	17	17	16
173								3	13	16	16	16	16	17
180									13	44	52	52	52	1
194									3	13	15	15	15	18
198										16	20	20	20	12
201										9	31	50	50	2
204										4	15	34	41	5

## 4 CONCLUSION

In this paper, we have described a procedure for modeling the strategic growth of firms in the Internet age by applying Simon's skew distribution model for business firm growth to Porter's strategic theories of industrial competition. We proposed an empirical test of the model, and provided the results from a simulation to demonstrate the applicability and usefulness of Simon's model for firms in the digital economy.

Largely fueled by the Internet, the competitive landscape is undergoing momentous change, which requires the reassessment of many of the fundamental theories and perspectives in information systems strategy (Clemons et al. 2001). This research study provides a valuable contribution in trying to quantitatively model the growth of firms in this new age. As the Internet continues to transform the competitive landscape, it is vital for managers to be able to understand the industries in which they compete. Such understanding opens doors for innovative directions of managing that can lead to competitive advantage and superior performance.

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