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An empirical study on firms' product entry strategy in the U.S. smartphone market

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Abstract

Prior studies often examine the effect of inertia on enterprise strategy for attracting new consumers or attacking competitors in an industry. Various sources of the firm act as inertia for the incumbents in the strategy; the most representative example is incentives. For incumbents, large incentives reduce competitive inertia and motivate them to change strategy. For example, poor financial performance acts as an incentive. This study asks the question: does prior good performance motivate managers to retain their strategies in a competitive environment? As products in modern society have a very short life span and change rapidly, it is very dangerous for a company to stay in one place without any change in their strategy. Therefore, this paper focuses on the relationship between past performance and strategic choices of firms, and considers managerial incentive as a mediator between the two, even in a rapidly changing society. We analyze three aspects of change in a firm's product strategies –market preemption, product diversification, and incremental product innovation—to observe the effect of inertia in the U.S. smartphone market. The results showed that past good performance resulted in some company strategies becoming passive. In addition, the past good performance of a company showed negative effects in expanding its market segment. The results were similar in terms of incremental product innovation. This implies that companies did not devote more time to product development once their products were valued well. Consequently, our paper empirically tested that past good performance caused inertia in product diversification and incremental product innovation strategies.

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I. Introduction

Inertia has been studied in various academic fields. Previous studies on inertia have also been carried out in the field of corporate strategy and the concept has been developed in ways that affect organizational changes (Hannan & Freeman, 1984). The inertia in the paper is called structural inertia, which usually analyzes firms' responses to new opportunities or new rivals in the market. More specifically, it has been found that the greater the inertia of organizations is, the slower enterprises' response to radical market changes or new environmental threats. Moreover, the size of the structural inertia varies with the age, size, and complexity of firms.

Inertia has been studied with regard to not only new markets but also the existing markets where incumbents compete. In Miller & Chen (1994) paper, they defined competitive inertia as organizational inaction that affects firms' strategic choices in the competitive market environment. According to Miller & Chen (1994), a high inertial firm is one which makes a less amount of changes in competitive markets compared to competing firms. They proposed three sources of competitive inertia in their paper based on literature survey: the incentive of managers to act, the awareness of action requirements or alternatives, and the constraints on managerial action (p. 3). Competitive inertia can be high when firm performance is good, managers acknowledge only limited alternatives, and organizations have certain characteristics that reduce organizational flexibility. The past financial performance of firm in the market is likely to be associated with competitive inertia because good performance can induce managers to stay put (Miller & Chen, 1994).

This paper focuses on the relationship between past performance and firm's strategic choices, and sets the incentive of managers as a mediator between the two. This article raises a question, whether the good performance of the past motivates managers to change less their strategies in competitive environment. In the existing paper, if a firm performs well in a market, the firm tend to reduce changes in its past strategic trajectory (Tushman & Romanelli, 1985). In other words, the good performance of the past is likely to induce firms to continue to pursue their existing strategies rather than change their strategies (Miller & Chen, 1994). On the other hand, the worse a company's past performance, the

greater the likelihood of reorientation (Lant, Milliken, & Batra, 1992). In short, the past good performance of a company is likely to reinforce its competitive inertia greater. Nowadays, as technology develops, the market is changing dynamically, resulting in the short product life span and the rapid progress of technology. In this rapidly changing environment, dynamic and strategic managements are needed for firms to create the wealth (Teece, Pisano, & Shuen, 1997). Firm also need to be careful but quick in decision making to reduce any loss (Bourgeois, 1988) because in the high velocity market, mistakes and delays immediately affect firms' cost and performance.

In this paper, we try to analyze whether past business performance in the market functions as inertia even in the rapidly changing market. In modern society, if a firm stay in one place without change, it will come to the firm as a disaster (Miller & Chen, 1994). Thus, it is very necessary to study the strategy change of enterprise in terms of inertia in modern society. In addition, there are some problems in previous articles that they analyzed the firm's strategy change as a percentage of the firm's investment in fixed assets (Miller & Chen, 1994), or simply as a number of products (Putsis & Bayus, 2001). However, there is a limitation that these analyses do not reflect the various strategies of the firm. Corporate strategies are most often expressed through product characteristics (Stavins, 1995) thus strategy analysis that does not reflect the characteristics of products has limitations. Therefore, this paper analyzes three aspects of firms' product strategy—market preemption, product diversification and incremental product innovation—that reflects the characteristics of products in order to understand smartphone manufacturers' strategic competition. Through this this paper examines whether past business performance acts as a competitive inertia in the U.S smartphone industry.

The remaining structure of this paper is as follows. Section 2 briefly explains smartphone specification improvements for the past five years and evolution of smartphones to help understand rapid market developments in the U.S. smartphone market. Section 3 proposes testable hypotheses based on relationship between the firm product strategies and the past performance. Section 4 introduces data collected for different generations of smartphones in the U.S. market and describes analytical

model of this paper. Section 5 reports the results of the analysis and Section 6 concludes the paper with discussing limitations.

II. Technological Development in the Smartphone Industry

The usage of smartphones has greatly expanded nowadays from a communication device for talking and texting to a multimedia device for watching multimedia content and playing games, not to mention talking and texting. As smartphones' usefulness improves, smartphone users have been increasing and the smartphone penetration rate among adults has reached 60 percent in 56 countries around the globe. Among them, UAE is ranked at the top with the highest smartphone penetration rate (90.8 percent), followed by Singapore (86.1 percent), Saudi (86.1 percent), Korea (83 percent) and the United States of America (70.7 percent).

Looking deeply into the properties of the smartphones, it is a cell phone as well as a handy portable computer that can perform as many functions as desktop computers do. It is a computer so it has an operating system, such as Android, iOS, and Windows, which are required to run applications and make internet connections. Smartphones have become a general purpose device that allows users to get an access to the internet anytime, anywhere and enables them to complete daily tasks such as watching videos, giving calls, transferring money, purchasing tickets, playing games and locating shops (Wijaya, 2013). The first smartphone was a Simon Personal Communicator introduced by IBM and BellSouth in 1994. It not only worked as a cell phone, but also offered a variety of functions including address book, global time, calculator, memo pad, e-mail and entertainment.

Smartphone performance and capacity have expanded rapidly since the first iPhone was released in 2007. New functions have been added and existing functions upgraded as components' performance was improved and mobile networks are upgraded. Smartphone manufacturers have contended for market share by enhancing performance and capacity of smartphones. Smartphone manufacturers have been competing aggressively over smartphone performance, especially in high-end smartphone markets (Wijaya, 2013). Smartphones are composed of several key components. Typically,

key smartphone features are determined by the performance of central processing unit (CPU), the capacities of internal memory, random access memory (RAM) and battery, and the resolutions of camera (primary and secondary) and display. Average specifications of smartphone components and average factory prices of smartphones are shown in Table 1, and the growth rates of average specifications and factory prices are also presented in Figure 1.

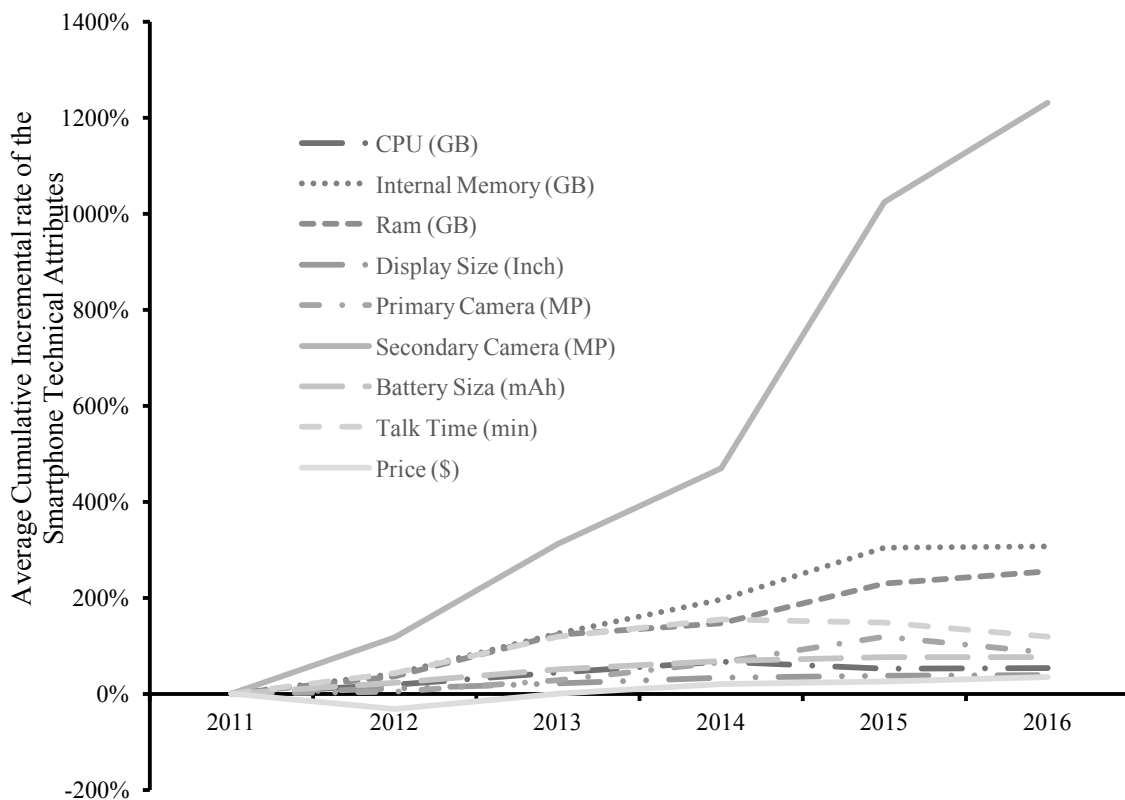
As shown in Table 1, the average speed of the CPU, which was 1.09 GHz in 2011, increased to 1.61 GHz in 2016. The average size of internal memory, increased from 8.22 GB to 33.46 GB during the same four years. Similarly, the average RAM size expanded from 0.67 GB to 2.38 GB. Other major technical features also increased steadily. Secondary camera (a camera installed on the front side of the smartphone) was added and quickly became a basic key component of smartphones. As shown in Table 1, the average mega pixel of the secondary camera, just 0.35 in 2011, became 4.68 in 2016. The performance of primary camera and the capacity of battery have improved in the same fashion for the same period.

Table 1. Changes in specifications and prices of smartphones between 2011 and 2016

Variable	2011		2012		2013		2014		2015		2016	
	Mean	Std. Dev	Mean	Std. Dev	Mean	Std.Dev	Mean	Std.Dev	Mean	Std.Dev	Mean	Std.Dev
CPU	1.09	0.23	1.24	0.30	1.51	0.38	1.75	0.58	1.59	0.35	1.61	0.42
Internal Memory (GB)	8.22	10.31	11.65	12.997	18.51	15.77	24.38	26.55	33.16	31.49	33.46	43.23
RAM (GB)	0.67	0.21	0.92	0.351	1.50	0.61	1.65	0.72	2.21	0.95	2.38	1.01
Display Size (inch)	3.71	0.63	4.12	0.606364	4.49	0.77	4.94	0.63	5.11	0.40	5.15	0.38
Primary Camera (MP)	6.09	1.67	6.37	2.023162	7.78	3.26	10.04	4.32	13.28	5.17	11.25	3.96
Secondary Camera (MP)	0.35	0.65	0.76	0.73831	1.45	0.78	2.00	1.54	3.95	2.21	4.68	1.93
Battery Size (mAh)	1505.20	329.62	1842.69	441.8602	2272.07	643.74	2523.21	547.88	2652.66	568.17	2659	532.15
Talk Time (min)	442.94	164.60	633.75	317.64	967.69	496.20	1129.89	481.12	1101.55	513.62	971.39	375.99
Price(\$)	320.73	208.08	220.01	84.49	320.73	208.08	385.86	216.71	402.34	220.78	430.11	281.33

Figure 1 shows average cumulative growth rates of the smartphone technical attributes over the five years from 2011 to 2016. The capacities and performances of key smartphone components increased on average by 271 percent between 2011 and 2016, but factory prices of smartphones increased only by 34 percent during the same five years. As shown in Figure 1, among the technical specifications of smartphones, technical progress of the secondary camera is ranked at the top by recording an average growth rate of 1231 percent during the five years, followed by internal memory (307 percent), RAM (254 percent), talk time (119 percent), primary camera (85 percent), battery capacity (77 percent), CPU (54 percent) and display size (39 percent).

Figure 1. Cumulative rate of change in average improvements of smartphone specifications



III. Theoretical Framework and Hypothesis

1. Firm's Product Strategies

Previous paper defined competitive inertia as an inertia that affects competition among firms in the market. This means the level of activity in which an enterprise attracts new consumers or attacks other competitors in an industry. Those kinds of activities appeared as corporate strategies and tactics in the previous paper. Strategy and tactic composed of actions - new products or services, price changes, incremental products and etc. - that represent their level of competition within an industry. In this paper, we try to analyze the firm strategy based on the existing paper, but reflect the characteristics of the products. More specifically we analyze the strategies which are used to attract consumers or attack other competitors in three ways - product diversification, market preemption, product incremental innovation - based on the product characteristics.

1.1. Product Diversification Strategy

Manufacturers are launching smartphones in the market every year through various strategies. However, until now, the research has only merely analyzed the strategic elements of these manufacturers as numbers of product or the formation of price. However, diverse ways of product strategies can be expressed by firms. One way to express their product strategy is segmenting and targeting (Kotler & Keller, 2012). It is the concept that whether the firm target a small market segment or the broader market segment. If firm targets on the small market segment it can be the way to increase efficiencies of maintaining and raise their marginal profit. It is the way the firm can do the local scope economies (Eaton & Lipsey, 1979). Moreover, this strategy helps firm to maintain their brand value.

Meanwhile, there is a way to capture a broad market to meet the needs of various customers. It is normally appeared in the heterogeneous customer base market (Brander & Eaton, 1984). Furthermore, company also need to consider cannibalization when releasing their new products (Desai, 2001). Products released by the company can compete with their own products, not competing with products of other companies. These problem can be solved by capturing a broad market rather than a narrow market. Companies also do not want new companies to enter their markets. Product

diversification strategy is the weapon to prevent entry of new entrants. Products that have been used for this disturbance appear to be greater than the minimum number required to deter entry (Bonanno, 1987). Therefore, this paper considers the product diversification strategy in order to understand the activities of the companies in the consumer aspect and the competition among the companies in the market.

1.2. Market Preemption Strategy

The firm's strategy can also be expressed using market preemption. When a company introduces their new models in the market, they have to choose whether they will compete in the crowded market space or pioneer a new market space. In the competitive high technology industry, the previous paper found that even though incumbents lose money at the margin they have to preempt the market before any entrant do (Nault & B, 1996). This strategy is also socially good that consumers will meet the improved products earlier. Furthermore, previous literatures empirically tested market preemption has the positive relationship with the firm performance (Ceccagnoli, 2009). In detail, those market preemptions with the high quality products resulted in a higher market share (Jacobson & Aaker, 1985). It is a way to make profits in the new market space before any other manufacturer's do (Bonanno, 1987).

Pre-occupying the empty market spaces, also helps incumbents to prevent new companies from entering the market (Bonanno, 1987; Spence, 1976). In Stavins (1995) paper, market barrier accompanying with a product preemption was empirically tested in the personal computer market. By releasing their products in all the empty spaces of the market, companies can prevent new entrants from entering the market in the future, and can improve firm performance by satisfying the needs of various customers. Therefore, in this paper, we analyze the market preemption, which is one of the corporate strategies, to further analyze the competition in the market.

1.3. Incremental Product Innovation Strategy

There are many types of innovation. According to Henderson & Clark (1990), innovation can

be divided into two categories: innovation impact on components and innovation impact on linkages between components. Incremental product innovation is the part of innovation impact on components. As new markets evolve, the biggest changes are incremental extensions to existing products (Sahal, 1981). It is also stated that innovation technological evolution often starts from the beginning of incremental product changes (Banbury & Mitchell, 1995). However, incremental innovation begins after product design is accepted in the market (Tushman & Anderson, 1986). By reason of incremental innovation refines and expands existing products, which usually means improving the performance of components while maintaining the core design concept of existing products (Henderson & Clark, 1990).

This incremental product innovation is the most important strategic element for companies in established markets (Banbury & Mitchell, 1995). In general, most of the firm's strategies are accompanied by product incremental innovation (Haynes, Thompson, & Wright, 2014). Incremental product innovation enables manufacturers to have the competitive force in a dynamic technological progressive industry and facilitate product differentiation (Requena-silvente & Walker, 2009). In Banbury & Mitchell (1995) paper, they analyzed incremental product innovation in the cardiac pacemaker market. The analysis shows that companies benefit from incremental product innovation even if their products may cannibalize their existing product sales. In addition, they empirically tested that the more frequent the incremental product innovation that firms do, the higher the market share they get in the market. Even though there are not many changes in the product, it has very significant economic results (Hollander, 1965). As the core design of smartphone market is fixed and incremental innovation progresses actively, it is necessary to analyze strategy for incremental product innovation. Therefore, this paper has discussed the incremental innovation of smartphones of manufacturers from the strategy perspective.

2. Firm's Competitive Inertia

The strategies mentioned in Section 3.1 are for launching different types of products rather than similar products or similar to what other companies offer. This is a strategy of offering products to different types of consumers rather than to their existing ones. It also means launching new products

that consumers do not consider highly reliable. Moreover, it is a strategy to attack other companies. Thus, this study attempts to analyze whether firms with high product evaluations will adopt this new strategy for new products in existing markets.

According to Hannan & Freeman (1984), firms prefer to increase performance reliability for their consumers. This is because consumers purchase products that meet a certain minimum quality with high certainty, even if the price is high. Therefore, the high reliability of performance means that the risk validity of products is low. For a firm to reproduce this reliability, it must make the same decision iteratively. It is also usual in the process of creating highly standardized routines. Thus, firms believe that they can benefit from providing great reliability in delivering a comprehensible product (Miller & Friesen, 1982). However, this reproducible process makes firms resistant to change (Hannan & Freeman, 1984). In other words, this process raises inertia, which ultimately makes the firm inflexible to new strategies (Lieberman & Montgomery, 1988). In addition, the larger the inertia in a firm, the less responsive it is to raising profits (Dean, Meyer, & DeCastro, 1993). In summary, this set of processes ultimately affects the company and its new strategy.

One factor that influences such reliability of performance is a firm's past performance. A company's existing experience or environmental background has a large impact of inertia on their new strategies (Boeker, 1988). Products that are highly recognizable by consumers have the advantage of lowering uncertainty. However, when creating a strategy for a new market segment, this process has a negative impact on the firm by acting as a learning effect (i.e., inertia). Therefore, according to Miller & Chen (1994), past good performance of companies plays a significant role in their inertia, making them passive in the next strategy. In addition, market share in the past acts as a major inertia in a firm's strategy, leading firms to create a similar strategy again (Farrell, 1986).

In addition, incumbent behavior is explained as competitive inertia (Miller & Chen, 1994). Competitive inertia is a measure of whether a firm takes a strategic form in the marketplace. This indicates whether the firm is attracting more customers or attacking other companies in the market. Therefore, large competitive inertia means that there is no major change in a firm's strategy. This competitive inertia is most pronounced when the market offers small incentives. Conversely, if a

company performs poorly, its manager will question the current strategy and gain motivation to change methods (Starbuck & Milliken, 1988). In other words, the incentive is so large that inertia falls, to find a new way. Therefore, past good performance is expected to have a negative impact on a firm's new strategy.

We use product rating (aggregate evaluation of the product by customers) as a measure in tracing past performance. Therefore, product ratings help us know product quality in terms of customers for a specific product (Moe, 2011). Moreover, high product ratings are good for measuring past performance of firms because it leads to high sales (Chevalier & Mayzlin, 2006; Clemons, Gao, & Hitt, 2006; Dellarocas, Chrysanthos, Zhang, & Awad, 2007). Ratings represent product performance at points in time, making them a good factor in understanding overall past performance. We posit our hypothesis as follows:

Hypothesis 1: High product rating will be negatively associated with product diversification

Hypothesis 2: High product rating will be negatively associated with market preemption

Hypothesis 3: High product rating will be negatively associated with incremental product innovation

IV. Data

1. Smartphone Data

To understand the strategy that reflects the product characteristics, we first analyzed smartphones that has been sold in the U.S. during the five years. The data consist of price and technical attributes of smartphones sold from 2011 to 2016. There were 370 different smartphone models released from six manufacturers during the five years. Each model contains the model's identification number, 17 different technical attributes, six manufacturers' name and the released date. Table 2 summarizes the major attributes of smartphones.

Table 2. Summary statistics for major smartphone variables

Variable	Min	Mean	Max	Std.Deviation
Price (\$)	54.37	319.94	1283	190.90
CPU (GHz)	0.48	1.46	2.7	0.451
Talk Time (min)	180	876.20	2880	473
Primary Camera (MP)	2	9.24	21	4.47
Secondary Camera (MP)	0	2.34	13	2.22
Internal Memory (GB)	0.51	22.20	256	28.81
Ram (GB)	0.27	1.60	4	0.96
Battery Size (mAh)	1000	2260.05	4100	670.70
Pixels Height (pixels)	320	1321	2560	773
Pixels Width (pixels)	240	773	1600	335.17
Height (mm)	101.3	135.33	167.6	14.20
Width (mm)	52.3	68.86	90.3	6.33
Depth (mm)	5.2	9.56	15.8	1.85

The smartphone models are classified by their brand names. However, if the brand names of any two models are the same but have different types of technical attributes, we categorized the models as different ones. For example, Apple released iPhone 6 for the three different internal memory versions. In this case we included all three data objects regardless of the brand name. Therefore, this paper includes all different technical types of the models that the manufacturer introduced in the U.S market. Technical attributes include the following: basic unit of programmable color, clock speed of the CPU/additional CPU (GHz), primary camera/secondary camera performance (MP), internal memory size (GB), ram size (GB), battery size (mAh), appearance of the smartphone like height (mm) · width (mm) · depth (mm) · weight (g) · display size (inch) and the length of the talk time (min). These attributes were selected based on previous studies. Furthermore, obtainability and measurability were considered when selecting the attributes.

2. Firm Performance Data

We used product ratings to understand the performance of companies in the market. Ratings were obtained through the GSMArc and GSMArena sites. These sites show the people's evaluation of each smartphone as a ten-point scale. Usually, each product reflected the opinions of about 50 people. Therefore, these sites were able to obtain consumer evaluations of each smartphone product. The market share value was obtained from comScore MobiLens. This site presents a monthly market share change for each smartphone manufactures in the U.S. Therefore, we used market share data for each smartphone manufacturer every quarter. As a result, we were able to get a consumer's assessment of the U.S smartphone manufacturers' products.

In our paper, we set variables of demand and threats of environments as control variables, to focus on whether past performance affects strategy. For that reason, according to the existing paper, there are various reasons for the enterprise to change their strategies. Among these reasons, the company's strategy can be changed by demands and threats of environment (March, Olsen, Christensen, & Cohen, 1976). Also, market condition was considered because in a rapidly growing market, managers take aggressive strategies to capture new opportunities (Miller, 1993). The definition of these variables is specified in table 3 and the descriptive statistics for each variable are described in table 4.

Table 3. Definition of variables

Variable Name	Variable Definition
RATINGS	Ratio of the average ratings of manufacturer <i>i</i> 's products to the industry average products ratings
MKSHARE	Market share for manufacturer <i>i</i>
FIRMAGE	Manufacturer's age (in quarters)
PRICE	Ratio of the average price of manufacturer <i>i</i> 's products to the industry average products price
NEWMODELS	Number of models that introduced in certain quarter <i>q</i> by manufacturer <i>i</i>
GROWTHRATE	Percentage growth rate in total smartphone users

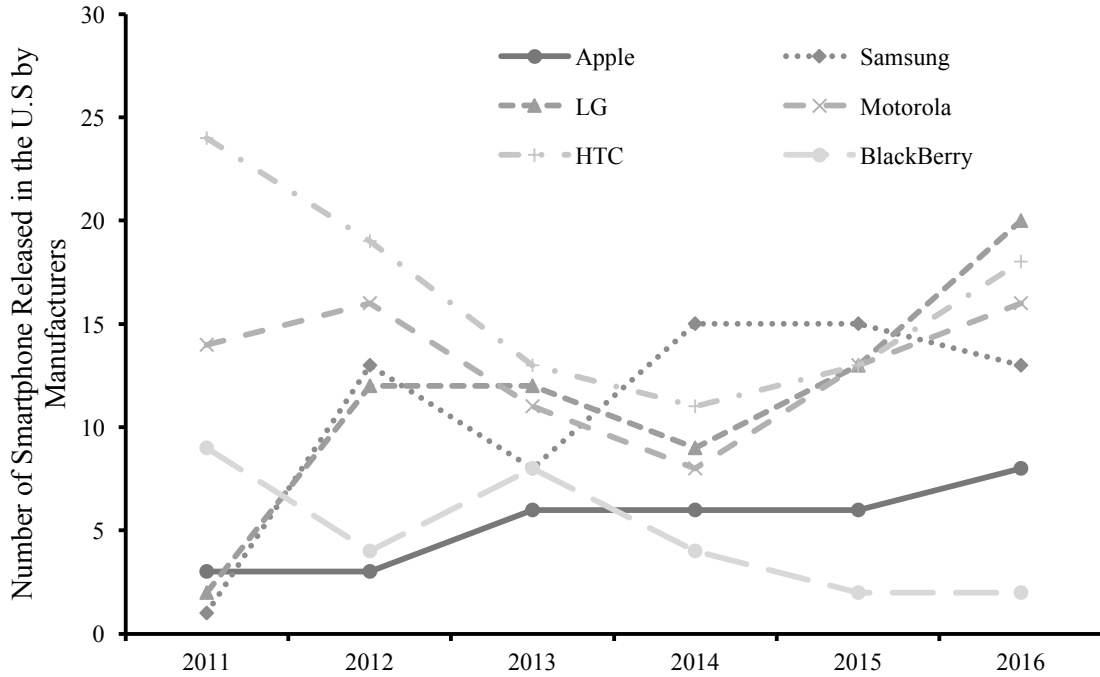
Table 4. Descriptive statistics of variables

Variable	Min	Mean	Max	Std.Deviation
Dependent variables				
Product diversification	0.0000	0.4854	1.5203	0.3203
Market preemption	0.2478	0.5126	1.1470	0.1781
Incremental product innovation	0.0000	0.2515	0.9953	0.2244
Independent variable				
RATINGS	0.7958	1.0059	1.1976	0.0688
Control variables				
MKSHARE	0.0080	0.1503	0.4410	0.1383
FIRMAGE	61	165.9	317	76.2926
PRICE	0.4805	1.0454	2.2680	0.4119
NEWMODELS	5	16.40	29.00	6.3453
GROWTHRATE	0.96	3.97	9.45	0.1011

V. Research Methodology

Smartphone manufacturers launch a variety of products every year. Figure 2 shows the number of smartphones released by manufacturers every year. According to figure 2, not every manufacturer releases products in a specific pattern. This is because diverse internal and external factors affect line decision strategies in the market (Putsis & Bayus, 2001). However, there are many limitations in analyzing a manufacturer's strategy through the number of products and not considering product characteristics. Therefore, we will first analyze each firm's products from a quality perspective and understand their strategy, which reflects product characteristics. Subsequently, we will analyze whether corporate inertia affects these three product strategies.

Figure 2. The number of smartphone models released in the U.S by the five major firms



1. Hedonic Estimation with Principal Component Analysis

In consumer theory (Lancaster, 1975), consumers obtain utility not by the product that consumer purchases but by the properties that consist the product. Thus, the properties are the factors that compose the complete product, and the summation represents the quality of the certain product. Therefore, finding the contribution of each property within a product is very important.

In a differentiated industry, varying technical properties within a product is a crucial requisite in a product placement decision. For products such as smartphones which have high innovation pace and short product lifespan, finding the contribution of each technical properties is difficult with the existing methods. In this case hedonic estimation provides each weight of the technical properties by the relationship with the price index. When computing the price index, not only the fixed cost of each product can be compared, but also the differences in technical development can be traced by the year dummy.

Comparing the vertically differentiated products which consist of 17 different types of

technical properties requires a modification from multi-dimensions to single-dimension. Hedonic regression makes it possible to regress smartphone price on its attributes. Also, this regression enables to differentiate different quality products on all over the time and across the whole products by using the year parameter. The year parameter causes hedonic surface to shift up and down and measure any changes that are occurred by the time on the logarithm of price (Haan, Jan, & Diewert, 2013).

However, hedonic estimation can be used when attributes are separable. Thus each variable should be independent, meaning that one variable does not affect other variables (Requena-silvente & Walker, 2009). Unfortunately, there is too much correlation between attributes in smartphones, as shown in table 5. For example, when a firm increases the quality of the primary camera, they also increase the quality of the secondary camera. Similarly, the internal memory capacity rises with the ram capacity. Therefore, we cannot use hedonic estimation alone to measure the smartphone quality. We must consider the correlation between variables. Thus, underlying hedonic estimation, we use the principal component analysis for the technical attributes to reduce the multi-dimension and correlation problem.

The principal component analysis is a method that reduces dimensions. It enables the transformation of correlated variables into a linear combination of independent variables. In addition, it also helps us in finding meaningful fundamental components of data from the covariance matrix. We have 17 different types of technical attributes, which require reducing dimensions and a meaningful basis. The PCA analysis obtains the best linearly independent attributes of smartphones. Moreover, our data sample size is suitable for the principal component analysis (Comrey & Lee, 1992).

As shown in table 6, the Kaiser-Meyer-Olkin measure was 0.903. This measurement explains whether the correlation between variables is explained via other variables. The value varies between 0 and 1, and close to 1 can use the principal component analysis. Our value was 0.903, which indicates that the principal component analysis is suitable. The Bartlett's Test also gave us good reason to use this model. Depicted in table 7, all the attributes are higher than 0.4, indicating that variables are well represented in the common factor space as shown in figure 3.

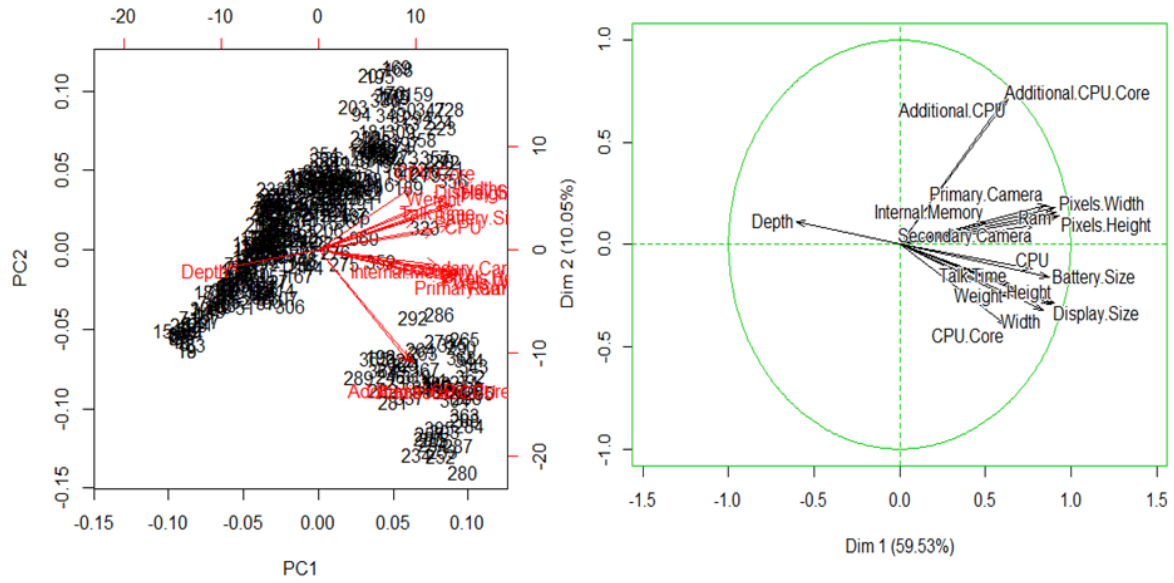
Table 6. Summary of the KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.903
Bartlett's Test of Sphericity	Approx. Chi-Square	7627.89
	df	136
	Sig.	0.000

Table 7. Summary of the communalities

	Initial	Extraction
Pixels Height (pixels)	1.000	.885
Pixels Width (pixels)	1.000	.863
Internal Memory (GB)	1.000	.508
Height (mm)	1.000	.899
Width (mm)	1.000	.829
Depth (mm)	1.000	.775
Weight (g)	1.000	.729
Display Size (inch)	1.000	.866
CPU (GHz)	1.000	.649
CPU Core (number)	1.000	.553
Additional CPU (GHz)	1.000	.927
Additional CPU Core (number)	1.000	.875
Ram (GB)	1.000	.857
Primary Camera (MP)	1.000	.775
Secondary Camera (MP)	1.000	.655
Battery Size (mAh)	1.000	.841
Talk Time (min)	1.000	.472

Figure 3. Variables factor map (PCA)



From figure 4, we used three components from the principal component analysis for hedonic estimation. As the eigenvalue, which is greater than one, contains many reliable factors; however, an eigenvalue smaller than one would have negative reliability (Kaiser, 1960). Table 8 summarizes the variance and cumulative of the model. Those three factors account for 76.213 percent of the total variance. Table 9 shows how attributes are weighted and also the correlation between the factor and the attributes.

Figure 4. Eigenvalue scree plot

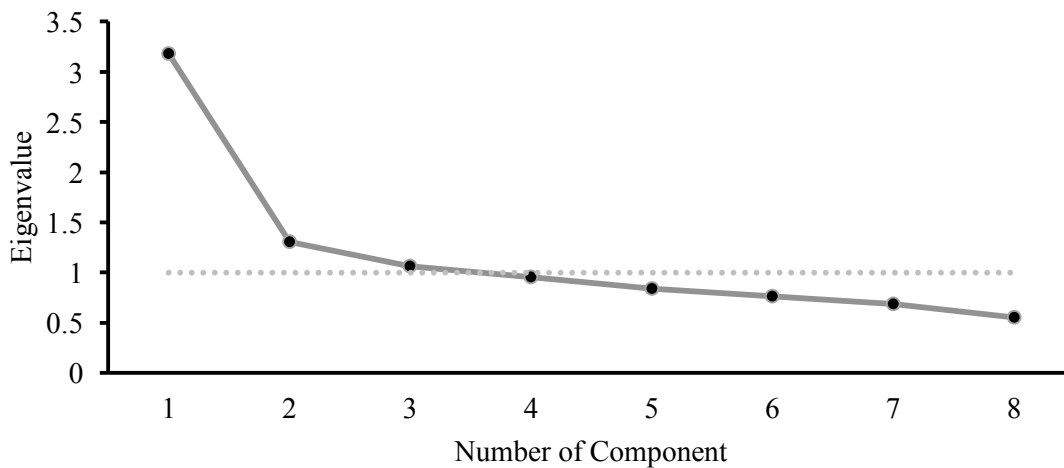


Table 8. Total variance explained by the components

Component	Weights of the rotated component		% Cumulative
	Total	% of Variance	
1	6.020	35.409	35.409
2	3.822	22.482	57.891
3	3.115	18.322	76.213

Table 9. Matrix of rotated components

Variable	Components		
	1	2	3
Width (mm)	0.847	0.186	0.278
Battery Size (mAh)	0.817	0.354	0.218
Height (mm)	0.815	0.220	0.432
Weight (g)	0.813	0.209	-0.155
Display Size (inch)	0.811	0.209	0.404
Talk Time (min)	0.634	0.195	0.177
CPU Core (number)	0.630	-0.032	0.394
Pixels Height (pixels)	0.592	0.584	0.440
CPU (GHz)	0.543	0.250	0.540
Additional CPU (GHz)	0.141	0.946	0.113
Additional CPU Core (number)	0.117	0.922	0.105
Primary Camera (MP)	0.526	0.600	0.373
Ram (GB)	0.531	0.598	0.467
Pixels Width (pixels)	0.577	0.593	0.423
Depth (mm)	-0.231	-0.084	-0.845
Internal Memory (GB)	0.098	0.246	0.662
Secondary Camera (MP)	0.468	0.451	0.482

The smartphone, however, has not only technical attributes but also some horizontal properties, which can affect the price and purchase decision. The brand is the most influential property in the horizontal characteristic (Joshi et al., 2015; Wijaya, 2013). As the brand is a symbol or perspective,

which helps distinguish one's product from others and loyalty impacts consumption. Product differentiation depends on not only the physical factor (vertical properties) but on other horizontal elements (Stavins, 1995). Therefore, to consider the impact of brand value, this study also includes brand dummy variables in the hedonic regression.

Hedonic regression analysis was conducted on smartphone retail price, principal components which were transformed from the major technical attributes, brand manufacturer dummies, and year of the model. For the dependent variable, log-linear form is used. Because for the high tech products, it is the way to reduce the problem from heteroscedasticity (Haan et al., 2013). The coefficient for each variable indicates the average marginal implicit prices in the hedonic equation. The coefficient has the information of the preferences (demand side curve) and the technology (cost side curve) (Epple, 1987). Thus, the crossing of the two curves would mean that the marginal cost equals to the marginal utility. Table 10 shows the main result of value to each attribute. For the model of any smartphone, the hedonic regression represents:

$$\ln P_{smt} = \alpha + \beta_1(COMPONENT_1) + \beta_2(COMPONENT_2) + \beta_3(COMPONENT_3) + \beta_4(D2011) + \dots + \beta_8(D2015) + \delta_1(SAMSUNG) + \delta_2(LG) + \delta_3(MOTOROLA) + \delta_4(HTC) + \delta_5(BLACKBERRY) + \epsilon_{smt} \quad (1)$$

Table 10^a. Hedonic regression from 2011 to 2016

Variable	Coefficient	t-Statistic
COMPONENT ₁	0.1593 ***	20.665
COMPONENT ₂	-0.0382 ***	-2.768
COMPONENT ₃	0.0520 **	2.867
SAMSUNG Dummy	-0.8291 **	-11.513
LG Dummy	-1.0223 ***	-13.775
MOTOROLA Dummy	-0.8402 ***	-11.497
HTC Dummy	-0.8727 ***	-12.848
BLACKBERRY Dummy	-0.8562 ***	-10.020

2011 Dummy	0.3092	***	4.068
2012 Dummy	0.3684	***	5.627
2013 Dummy	0.3734	***	6.118
2014 Dummy	0.2639	***	4.345
2015 Dummy	-0.0137		-0.244
Intercept	6.0698	***	82.024

Adjusted R-square=0.7558, $R^2 = 0.7651$, N=370

Model F=81.69, P=0.000

^a In the equation, 10 dummies and 3 components are examined. For the brand dummy, six manufactures are included and the Apple is the reference dummy. For the year, six durations are included and the 2016 is the base dummy.

Categorizing smartphones as vertically differentiated products allow us to analyze the quality value for each product. Since the smartphone has many technical attributes to be considered, a methodology was adapted from previous research to reduce the multidimensional problem to the linear scale (Stavins, 1995). This approach uses the coefficient in Table 10 as the weight of each attribute real value. The complex specification of each model is solved by the summation of each weighted coefficient value, and the summation values represent the quality of each product. Therefore, the overall quality of the model can be written as:

$$q_{smt} = \alpha + \sum_{i=1}^7 \beta_i z_{is} + \sum_{j=1}^5 \delta_j x_{js} + \epsilon_{sm} \quad (2)$$

where,

z_{is} = value of i^{th} attribute for smartphone ($i = 1, 2, \dots, 7$);

x_{js} = value of j^{th} brand value for smartphone ($j = 1, 2, \dots, 5$);

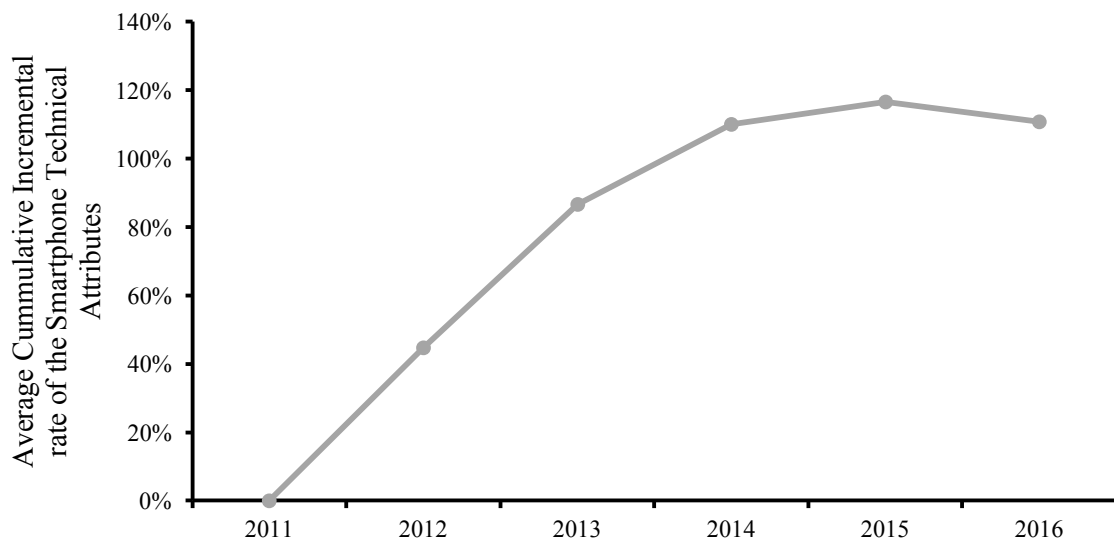
β_i = weight of i^{th} attribute

δ_j = weight of j^{th} brand value attribute

Transforming multidimensional product specification to the linear scale enables us to represent

the total attributes quality as a numerical value. Figure 5 depicts the average annual shifts in the quality index of smartphones each year. The average quality index of the smartphone has increased until 2015, but decreased at 2016. The average quality on the smartphone increased 117 percent in 2016 compare to 2011.

Figure 5. U.S Smartphone market quality index calculated from equation (2) (2011-2016)



1.1. Analysis Method of Product Diversification Strategy

Diversity of products is the way to take broad market and create the barrier to deter any new manufacturers. To measure each firm's product diversification in a given year, this paper uses a measure of within dispersion. Previous literature used the number of model as the barrier but optimal point of the entry deterrence came from the product location, not arises from the number of products (Bonanno, 1987). Thus it is the appropriate measure to examine each firm's product diversification strategy. We measured the within dispersion every quarter, and the within dispersion included the past year's products, including the quarter. Within dispersion shows each manufacturers' product line strategy that explains how widely the smartphones are released in the quality space. To put it another way, small dispersion

rate indicates whether manufacturers are diversifying their models in the quality space, they more likely to focus on the small market space.

$$\sigma_{mq} = \frac{\sum_{s=1}^{S_{mq}} (q_{smq} - \bar{q}_{mq})^2}{S_{mq}} \quad (3)$$

where,

$$\bar{q}_{mq} = \frac{\sum_{s=1}^{S_{mq}} q_{smq}}{S_{mq}}; \text{ and}$$

S_{mq} = numer of smartphones by manufacturer m in quarter $q - i$ (where $i = 0,1,2,3$)

However, to verify the degree of concentration of models for each market sector in year t, this paper uses relative dispersion as a measurement. Each of absolute dispersion is converted into the relative dispersion, thus enabling us to compare the sets intuitively. The relative dispersion index shows:

$$R_{mq} = \frac{\sigma_{mq}}{\sigma_q} \quad (4)$$

where,

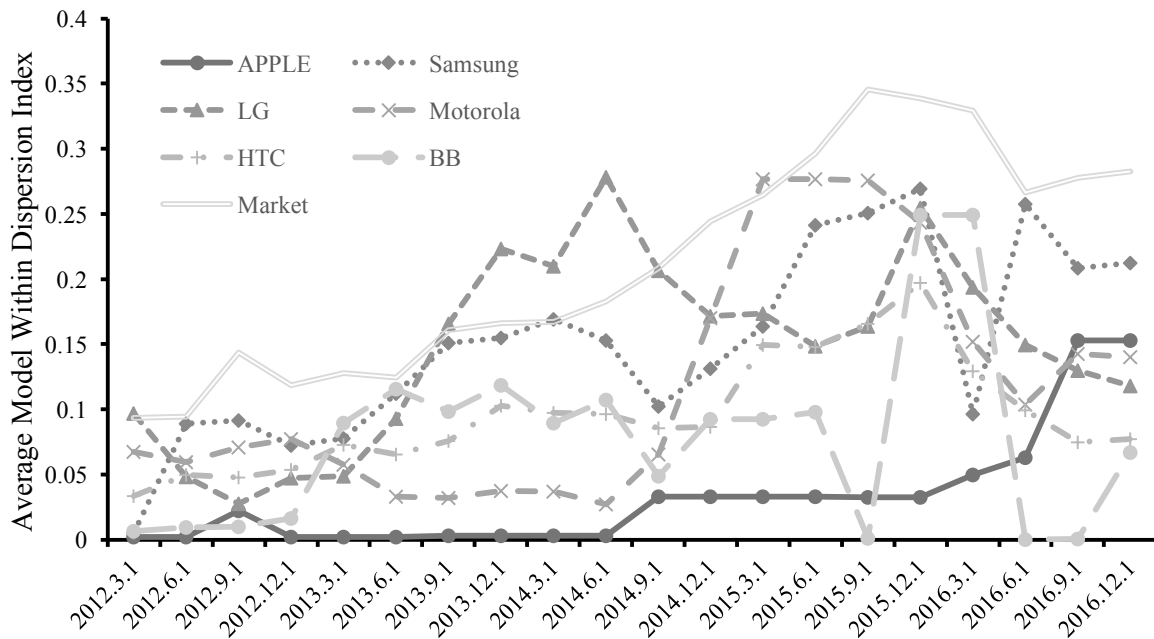
$$\sigma_q = \frac{\sum_{n=1}^{N_q} (q_{nq} - \bar{q}_q)^2}{N_t};$$

$$\bar{q}_q = \frac{\sum_{n=1}^{N_t} q_{nq}}{N_q}, \text{ and}$$

N_q = total number of smartphones in year quarter $q - i$ (where $i = 0,1,2 \text{ and } 3$)

The σ_t indicates the total dispersion in year t , and thus R_{mt} shows each firm's relative value of the absolute dispersion from the total market dispersion. As can be seen in the Figure 6, all of the manufacturers in the U.S smartphone industry showed high fluctuation over the five-year periods. Apple maintained the lowest within dispersion rate since 2012 however it increased significantly after 2016. Most of the periods, Samsung and LG showed the high level of within dispersion. The BlackBerry continued to maintain a steady within dispersion rate, but began to fluctuate significantly in December 2015. Market within dispersion is increasing over times.

Figure 6. Each manufacturer's within model quality dispersion index from 2012 to 2016



1.2 Analysis Method of Market Preemption Strategy

To calculate each smartphone's placement when introduced in the market, this paper uses a measurement of the average distance from all smartphones that released in the previous year:

$$\bar{d}_{smq} = \frac{\sum_{n=1}^{N_{t-1}} \sqrt{(q_{smq} - q_{s,q-i})^2}}{N_{t-1}} \quad (5)$$

where,

N_{t-1} = number of smartphones in year $t - 1$;

q_{smq} = quality of smartphone s by manufacturer m in quarter q ; and

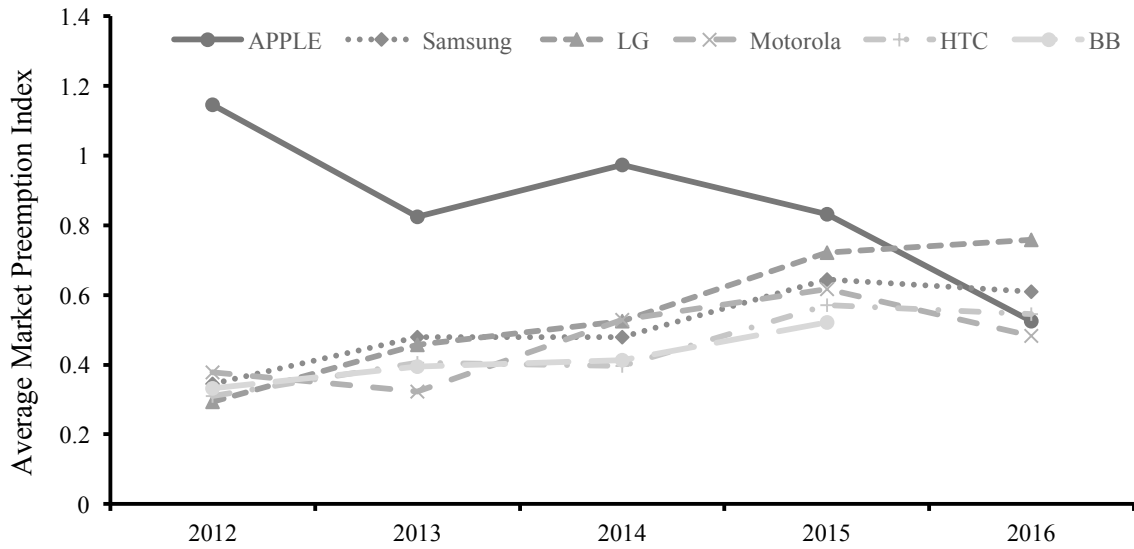
$q_{s,q-i}$ = quality of smartphone s in quarter $q - i$ (where $i = 1,2,3$ and 4);

By linearizing multidimensional product specification into the numerical value as the quality, neighbor models of every smartphone models can be identified. These neighbors can affect any certain model when consumers are deciding on their purchase. Since manufacturers introduce various models every year, we construct the average distance index for the firm in each quarter. Therefore, this measurement explains the distance between any new model and earlier models from a quality-adjusted price perspective.

$$\text{distance}_{\text{firm}} = \text{mean}(\bar{d}_{smq}) \quad (6)$$

Figure 7, depict the market preemption rate of each manufacturer in the U.S. smartphone industry from 2012 to June 2016. The manufacturer Apple have had a higher fluctuated market preemption rate than the other manufacturers from 2012 to 2015. In 2016 Apple ranked fourth in the U.S smartphone industry. Mostly, the graph line of the manufacturers increased consistently as time passes.

Figure 7. Each manufacturer's market preemption rate from 2012 to 2016



1.3 Analysis Method of Incremental Product Innovation Strategy

Incremental product innovation is an important factor that determines a firm's competitiveness in established industries. Measuring the incremental product innovation of each manufacturer, this paper uses distance to frontier method that has been used in the high-tech industry by Fontana & Nesta (2007) paper. We decompose quality of each product (eq. 2) into three elements. The q_{smt} variable stands for the product vertical quality that subtract brand quality from the total quality. This variable enables to compare each of smartphones from the vertical technology perspective.

$$\hat{q}_{smt} = q_{smt} - \sum_{j=1}^5 \delta_j x_{js} \quad (7)$$

Then using the previous literatures, we measure the distance of the product quality from the frontier. It means we order each smartphones that has been introduced from each manufacturer into the vertical product space. Thus the distance from the frontier as follows:

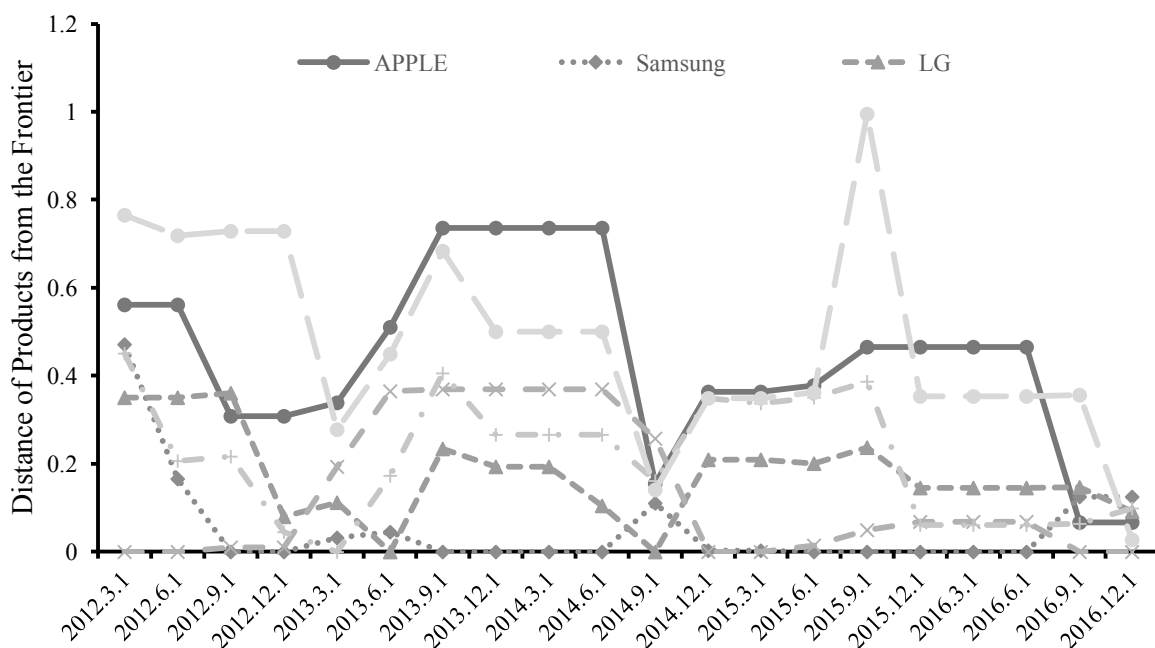
$$d_{smt} = \max(\hat{q}_t) - \hat{q}_{smt} \quad (8)$$

For each firm, they release several models every quarter, we explore the minimum distance to vertical technological frontier. The higher the d_{mt} , the lower that the product is from the technological development.

$$d_{mt} = \min(d_{smt})_{mt} \quad (9)$$

Figure 8 presents the result of the distance of product from the technological frontier during the five years. Overall, incremental product innovation can be seen to fluctuate. Still, most of the periods, manufacturer Samsung releases high quality of smartphones. Also Motorola do focus on developing the high quality of smartphones.

Figure 8. Each manufacturer's distance of products from the vertical technology frontier



VI. Results of the Analysis

Prior to analyzing whether past firm performance affects their next strategies, we analyzed whether there is a correlation between the three product strategies. Table 11 shows the similarity of each product strategy, showing low correlation with each other. Therefore, we were able to analyze whether inertia affects the three product strategies.

Table 11. Correlation matrix between three firm product strategies

	(1)	(2)	(3)
(1) PRODUCT DIVERSIFICATION	1		
(2) MARKET PREEMPTION	0.2762	1	
(3) INCREMENTAL PRODUCT INNOVATION	-0.3246	0.0785	1

Table 12 represents how past performance and external factors in the market affect corporate strategies. Table 13 presents the correlations of the variables. All of the independent variables in the analysis took the lagged form. First, we examined how a company's product ratings affect its diversification strategy as inertia. The analysis showed that the higher the product ratings in the past, higher the inertia, which negatively affects corporate diversification strategy. This means that if past market performance is high, the company does not release for a wider market when it launches its new products.

On the other hand, in market preemption, the past performance of the company does not result in inertia. As a control variable, market share has a positive effect on market preemption. As shown in figure 7 this result seems to be due to the high market share of APPLE. Therefore, we need to add more companies in this area for more specific analysis.

Finally, we analyzed whether past financial performance affects incremental product innovation. The dependent variable is the product innovation frontier minus the quality of each company's best-spec product. Therefore, a positive number in the result means that the product is away

from the product innovation frontier. Therefore, we can see that the past performance of the company has a negative effect on incremental product innovation. That is, if the past performance of the company is high, it does not release a higher specification product when launching a new product.

We conclude that product rating, which is a result of past company performance, negatively affects product diversification and incremental product innovation strategy. On the other hand, there was no effect on market preemption. Broadly, the analysis shows that past product performance and product ratings have a negative impact on a company's next strategy (product diversification and incremental product innovation) as inertia.

Table 12. OLS estimation results for the firm performance on the strategies

	PRODUCT DIVERSIFICATION	MARKET PREEMPTION	INCREMENTAL PRODUCT INNOVATION
RATINGS	-0.2341 * (-2.501)	0.3405 (1.199)	1.3132 *** (4.423)
SHARE	-0.2687 ** (-2.666)	1.1252 *** (3.659)	1.2829 *** (4.013)
FIRMAGE	0.0004 *** (4.618)	-0.0005 . (-1.745)	-0.0019 *** (-6.094)
PRICE	-0.0210 (-0.683)	-0.1749 (-1.648)	-0.1737 . (-1.777)
NEWMODELS	0.0009 (0.809)	0.0002 (0.069)	0.0038 (1.096)
MKTGROWTH	0.0052 (0.770)	-0.0049 (-0.246)	0.0155 (0.724)
QUARTER	0.0101 *** (3.806)	0.0146 . (1.855)	-0.0009 (-0.103)
Intercept	0.2037 . (1.759)	0.1408 (0.402)	-0.8790 * (-2.394)
N	96	73	96
Adjusted R-square	0.5084	0.3509	0.3924
p-value	0.000	0.000	0.000

Table 13. Correlation matrix between variables

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) RATINGS	1						
(2) SHARE	-0.3842	1					
(3) FIRMAGE	-0.1713	0.5611	1				
(4) PRICE	-0.3151	0.7697	0.1568	1			
(5) NEWMODELS	0.0121	-0.0132	-0.0410	-0.0167	1		
(6) MKTFROWTH	-0.1380	-0.0423	-0.0543	0.0645	0.0288	1	
(7) QUARTER	0.1141	0.0435	0.0847	-0.0528	-0.1216	-0.8796	1

VII. Conclusion and Limitations

Inertia is a factor that influences the individual, organization, and the company. Such inertia affects companies in various ways. Generally, the larger the inertia in the firm, the more likely it is to react late when new opportunities or new competitors arise. Therefore, in existing articles, inertia within the company will eventually lead to its destruction. We also analyze whether inertia affects incumbents in existing markets rather than new markets. According to the prior paper, this inertia also acts on existing companies, making them passive in their new strategies. In addition, if this inertia continues, it will result in a disaster for the company.

From the company's perspective, incentives can explain this inertia. The worse the company's performance in the past, the more incentive exists for them. For example, the manager of a company will think about his current strategy and try to change it if there is a problem. Thus, this can be a driving force for companies in changing their strategies. Moreover, poor performance in the past will act as an incentive for the enterprise, which lowers inertia and promotes new strategies. If so, will good performance in the past, which lowers incentives for a firm, causes strategies to remain the same? As modern products have a very short life span and change rapidly, it is very dangerous for a company to stay in one place without changing their strategy. Therefore, in this study, we tried to analyze whether past good firm performance affects as inertia, even in a rapidly changing modern society.

Prior studies analyzed firm strategy according to market flow, as the change in investment on fixed assets, or calculated the decrease rate of products. However, this analysis is insufficient for understanding strategies in terms of companies. In addition, there are many difficulties in understanding company strategy from the consumer's perspective. Therefore, in this study, we tried to understand corporate strategy at the product level. This is because at the product level we can understand the strategic nature of the firm and reflect on product evaluation on the consumer side. Moreover, we analyzed corporate strategy in three dimensions –product diversification, market preemption, incremental product innovation- at the product level. That is because these three strategies are suitable for understanding a company's strategy change to fits into a broader or different market, rather than targeting past consumers. Through this, we analyzed whether past performance results in passive strategy.

The analysis results show that high past performance makes some strategies passive. The past good performance of a company has negative effects on expanding the market segment. It means that when a company performs well in the past, it launches new products into an existing market segment rather than in wider market segments. Therefore, it seems to inhibit market expansion. Similar results were obtained in terms of incremental product innovation. The company's past good performance had a negative impact on product development. This means that companies did not devote more time to product development once their products were well valued. However, there were no significant relationships between past performance and market preemption strategies.

However, this study has several limitations. First, the number of companies is too small. Six companies account for more than 90 percent of the U.S. smartphone market; however, the remaining companies do not account for even 1 percent of the total market share. Therefore, there is no measuring of market share data for companies with low market shares. Thus, we cannot include more manufacturers in the analysis. As the number of companies is too small, the influence of the corporation is large in the analysis. In the next study, we can expand the market to consider more companies.

The second is a problem with variables that measure firm performance. We have used the rating for measuring firm performance. However, its analysis is from the consumer side and not from the corporate side. Many studies empirically tested ratings from the perspective of the enterprise, as it attracts high sales. However, it is necessary to analyze whether ratings also call for high sales in the US smartphone market. In spite of these limitations, this study is meaningful in that it is the first to analyze inertia in company strategies at the product level.

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Table 5. Correlation matrix of smartphone technical properties

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
(1) Pixels height	1.000																
(2) Pixels width	.959	1.000															
(3) Internal memory	.477	.469	1.000														
(4) Height	.773	.739	.390	1.000													
(5) Width	.679	.692	.303	.914	1.000												
(6) Depth	-.527	-.512	-.425	-.622	-.505	1.000											
(7) Weight	.533	.528	.270	.636	.672	-.036	1.000										
(8) Display size	.776	.717	.351	.944	.859	-.598	.611	1.000									
(9) CPU	.774	.767	.480	.630	.571	-.504	.462	.647	1.000								
(10) CPU core	.507	.484	.188	.666	.588	-.397	.321	.648	.461	1.000							
(11) Additional CPU	.665	.662	.282	.407	.363	-.271	.264	.394	.306	.123	1.000						
(12) Additional CPU core	.604	.599	.259	.389	.338	-.242	.234	.378	.288	.180	.909	1.000					
(13) RAM	.869	.872	.479	.734	.674	-.530	.484	.700	.739	.511	.675	.615	1.000				
(14) Primary Camera	.815	.801	.418	.681	.619	-.448	.486	.673	.677	.493	.639	.612	.796	1.000			
(15) Secondary Camera	.671	.660	.443	.734	.632	-.507	.399	.663	.498	.552	.527	.541	.741	.706	1.000		
(16) Battery Size	.766	.758	.301	.808	.802	-.427	.616	.813	.631	.574	.483	.451	.746	.702	.613	1.000	
(17) Talk time	.580	.569	.268	.546	.519	-.356	.437	.555	.501	.336	.296	.231	.516	.509	.380	.707	1.000

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