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Do “Digital” Firms Live Longer as Fields Converge? A Survival Analysis of the S&P 500

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Abstract

We report on a study of firm longevity as we move from the industrial age to the digital age. Through a survival analysis of S&P 500 firms from 1965 to 2016, we find that firms survive for a decreasing duration over time. This indicates that the pace of innovation is increasing as we transition to the digital age. Further, we find that this duration is longer for non-digital firms than digital firms, indicating a generally fiercer competitive landscape for digital firms. Finally, we find that this difference between digital and non-digital firms largely disappears after the 1990s when the digital age has firmly taken root. This study thus provides the first large-scale evidence for digital field convergence – a term we use to describe the blurring of industrial distinctions in the digital age as all firms are becoming digital firms.

Keywords

Digital firms, survival analysis, digital age, pace of innovation

Introduction

Recent decades have ushered in the digital age, and many believe that the digital age follows different rules than its predecessor – the industrial age (Brynjolfsson & Kahin 2002). In the digital age, innovation and disruption are thought to occur at a faster clip (Brynjolfsson & McAfee 2014) and the old rules of organizing are being undermined by Internet-based arrangements that transcend the boundaries of traditional organizations and change the way value is delivered (Bharadwaj, El Sawy, Pavlou, & Venkatraman 2013; Winter, Berente, Howison, & Butler 2014; Barrett, Davidson, Prabhu, & Vargo 2015).

During this transition to the digital age, "digital firms" hold a special position. As those firms with digital (software and computer-based) technologies as a key component of their business models, digital firms are instrumental in ushering in this new mode of business and competition (e.g. Gnyawali, Fan, & Penner 2008; Woodard, Ramasubbu, Tschang, & Sambamurthy 2012). We refer to firms with digital technologies such as software and computer-based products as "digital firms." Digital firms have built capabilities with digital technologies, and therefore will be better equipped to sense and respond to market opportunities (Sambamurthy, Bharadwaj, & Grover 2003; Karimi & Walter 2015). However, they compete with other digital firms who also have these capabilities. Digital firms compete squarely in the most tumultuous and dynamic competitive environments, with reduced barriers to entry and hypercompetition (Grover & Kohli 2013; Hirt & Wilmott 2014), indicating that digital firms might have shorter lives compared to non-digital as a result of competing in such turbulent fields. However, these differences may be changing, because, with the dawn of the Internet, all firms are becoming digital, to a degree (Grover & Kohli 2013; Bharadwaj, El Sawy, Pavlou, & Venkatraman 2013). Thus the lines between different industries are blurring – a phenomenon we refer to as "field convergence." Due to field convergence, any differences between digital and non-digital firms would likely reduce in the wake of the Internet, because all firms will be subject to highly dynamic digital innovation. Therefore, we ask: *do digital firms survive longer than industrial firms? Further: do these survival rates change in the wake of field convergence?*

To answer these questions, we conducted a survival analysis of 1,409 firms in the S&P 500 index for each year from 1965 to 2016. We found that the duration for survival of firms on the index is shortening overall – indicating that the pace of change is indeed accelerating. Further, we find that digital firms do have shorter life spans than non-digital firms across our sample, but this difference reduces dramatically and is no longer significant after the 1990s. These findings provide empirical support for the notion that things are more dynamic, disruptive, and changing at a faster pace in digital fields than in industrial. Also we show evidence for digital field convergence.

The remainder of the paper is organized as follows. First we briefly review the relevant literature distinguishing between digital firms and other firms, as well as the shift from the industrial to digital age in terms of different "fields" of firm activity. Then we articulate our competing hypotheses and test these hypotheses. We conclude the paper with a reflection on the implications of our findings with respect to fields and digital innovation.

The Digital Age and Digital Fields

In recent decades, many scholars have noted that something is changing. No longer are the assumptions inherent in the industrial age universally relevant. There has been a shift. Huber (1984) referred to this as the "post-industrial society." He indicated that information technology and the related competitive environment marked by incessant innovation and competition on information define this new age. Those firms that are best equipped to handle this age will survive. Since then many have used a variety of terms including "knowledge economy" (Adler 2001), "information age" (Castells 1997), "network age" (Varian 1999), and others. We adopt the term "digital age" to be consistent with much of the recent work in information systems research (i.e. Overby 2008; Gnyawali, Fan, & Penner 2008; Belanger & Crossler 2001; Barrett, Davidson, Prabhu & Vargo 2015). Irrespective of the view, the notion remains the same – due to advancements in digital technologies such as those related to computers and software, the very nature of competition and organizational success is changing. There are a number of notions important to this change, including a faster pace of innovation, reduced barriers to entry, and digital convergence. Next we discuss each of these:

Faster Pace of Innovation

It is commonly accepted that the pace of innovation is increasing in the digital age (Yoo, Lyytinen, Boland, & Berente 2010; Brynjolfsson & McAfee 2014). At the very core of digital technologies is the processor, and since processors reduce in price while at the same time doubling in performance every year (Moore's Law), this enables all sorts of derivative innovations. This dramatic increase in price performance is at the core of the faster pace of innovation in the digital age (Sampler 1998; Jorgenson 2001).

Further, digital technologies are particularly open-ended and generative. Digital technologies take the form of a modular stack, where the upper layers are open to all sorts of open ended, emergent innovations (Yoo, Henfridsson, & Lyytinen 2010). This open-ended, standardized architecture is editable, interactive, reprogrammable, and distributable, leading to limitless and unpredictable combinations (Kallinikos, Aaltonen, & Marton 2013). The combinatorial nature of digital technologies as critical multi-purpose technologies drives the accelerated pace of innovation in the digital age (Yoo, Boland, Lyytinen, & Majchrzak 2012; Brynjolfsson & McAfee 2014).

The cell phone industry's remarkable growth is an example of the dynamic nature of the digital age. Throughout the nineties, cellphones grew sleeker and became universally owned. The first text message was sent in 1992; and in eight short years (2000), the first commercial camera phone was released. By the early 2000s, the cellular infrastructure had evolved from 1G to 2G to 3G. Blackberry and Palm revolved as industry leaders, and in 2007, Apple introduced the iPhone. A year later, Google unveiled Android. Smartphones have since become omnipresent, hold the computing power of supercomputers from decades ago, and enable a previously unimaginable amount of potential in the applications that are available. The case of cell phones demonstrates an important trend among digital firm competition. Even as new companies step in or are pushed out, the jockeying for power in this industry requires constant surveillance of the markets and significant research and development to create new technologies that will satisfy consumers more than competing companies (Zhou & Wu, 2010). The evolving nature of markets in which digital firms compete causes continuous displacement of firms unable to keep pace with market evolution, thus requiring firms to have dynamically adjust to the changes (Helfat, 2011).

Barriers to Entry

It has long been understood that digital technologies reduce certain barriers to entry in markets (McFarlane 1984). In particular, the barriers in industries involving information goods such as magazines and music have proven vulnerable to attack from outside the industry, largely because information goods are non-rivalrous and non-excludable (Shapiro & Varian 1999). Other industries also are vulnerable to disintermediation and disaggregation due to communication and coordination benefits of digital technologies (Tapscott 2000). The lower barrier to entry has revolutionized competition because in many industries competitors can pop up with minimal capital outlays. Many current leaders such as Amazon, Uber, and Netflix that arose without the capital outlays required by their industrial age competitors.

With digital technologies, physical location is no longer a serious constraint facing companies that may have once only have operated locally. Digital technologies extend the reach of organizations (Sambamurthy, Bharadwaj, & Grover 2003) beyond the bounds of what was capable in the industrial age. On the day they are founded, firms can effectively reach the entire globe with their services.

Digital Field Convergence

Originally there were many different types of digital technologies with numerous competing standards. However, in recent decades, a reduced set of architectural standards have emerged around the Internet in the form of an open stack (Yoo, Lyytinen, Boland, & Berente 2010). This “convergence” of technologies (Lyytinen & Yoo 2002) has accelerated the standardization across what were previously distinct industries (Tumbas, Berente, & vom Brocke 2017). Now all sorts of formerly distinct industries are overlaping around digital standards.

Diverse products or services across industries have been embedded and enhanced with digital features and technologies, and the pool of companies using such technology is expanding. The need for digital technology has increased on both the supply and demand side. Tech-savvy consumers expect personalized products that will most effectively accomplish their desires, so firms need to understand their consumers’ preferences in a deep way (Venkatesh, 2012; Mithas, Ramasubbu, & Sambamurthy, 2011; Davenport, 1992). The increasing demands of organizational information technologies by customers and suppliers across industries has benefitted companies that often operated independently from such available technology analysis resources. Specifically, as demonstrated by previous research, IT facilitates product development (Pavlou and El Sawy, 2006), customer service quality (Ray et al., 2005), quality management practices (Perez-Arostogui, 2015), and entrepreneurial culture (Benitez-Amado et al., 2010). Companies using a variety of information technologies reap rewards that have enticed additional companies to enter the markets (Mithas, Ramasubbu, & Sambamurthy, 2011). In sum, all firms need to build digital capabilities and employ digital strategies (Grover & Kohli 2013).

Thus we find that the fast-pace of digital innovation, the reduction of barriers between industries, and the convergence of digital technologies has resulted in a sort of digital “field convergence” across industries. In the past industries “contained” organizations (Winter, Berente, Howison, Butler 2015) but this industrial distinction is lessening. Instead, many diverse organizations are competing in the same space – what we refer to as a “field.” Fields can be contrasted with traditional industries in that a field implies a set of practices that transcend any particular industry (Wooten & Hoffman 2008). There are a variety of new cross-industry fields emerging in the digital age (Avgerou 2000; Munir & Phillips 2005; Levina & Arriaga 2014) and every industry is influenced by digital technologies to some degree (Grossman 2016). Next we hypothesize about the how field convergence influences the way different sorts of firms thrive.

Hypotheses

Throughout the second half of the 20th century to the present day, the industrial age is giving way to the digital age. Our first argument is that the digital age involves a faster pace of innovation and competition. This combined with reduced barriers to entry and one would expect to see firms remain viable for shorter periods of time. Simply, with a faster pace of innovation and the resulting digital disruption, as well as the multitude of dynamically emerging increasing possibilities, the average term for firm survival should decrease over time during the transition to the digital age, leading to our first hypothesis:

> ***H1: As the economy transitions from the industrial age to the digital age, firms will survive for shorter durations over time.***

Of course, digital firms should relate to the emergence of the digital age differently than non-digital firms. After all, digital technologies are fundamental to their DNA (Tumbas, Berente, & vom Brocke 2017). For digital firms to have success over time they need to maintain dynamic capabilities which will enable them to innovate and battle potential disruptive threats (Helfat, 2011; Karimi & Walter 2015; Grover & Kohli 2013; Hirt & Wilmott 2014). Digital firms must be dynamic to stay ahead of their advancing industries.

The question is, does this mean that digital firms will survive for longer durations than non-digital firms? This is not an unproblematic question. On the one hand, one would expect digital firms to last longer in the emergence of the digital age, because they are better equipped to handle the dynamic information and knowledge intensive requirements of the tumultuous landscape. On the other hand, they compete primarily with other digital firms, who are also well-equipped to innovate digitally and these firms together accelerate the pace of innovation and disruption. Since digital firms throughout the last half century compete largely with each other, we would expect the pace of digital innovation to impact these firms more than non-digital firms. Thus we hypothesize:

> ***H2: As the economy transitions from the industrial age to the digital age, digital firms will survive for shorter durations than non-digital firms.***

Finally, it is important to note that the emergence of the digital age accelerated dramatically during the 1990s. With the birth of the Internet, people could instantaneously share data around the world, globalizing connections and understanding (Berners-Lee, 2000), laying the groundwork for the stack of standards that enabled unprecedented digital innovation (Yoo, Henfridsson, & Lyytinen 2010). It was also in the 1990s that processing power reached major milestones and at costs that were inexpensive enough for wide dissemination (Sampler 1998; Jorgenson 2001). This combination led to the widespread use of digital technologies in all industries and the subsequent digital “field convergence” that we identified. Thus, if in the wake of the 1990s all firms were, to an increasing extent, digital, one would expect any difference in survival rates to be reduced, leading to our third hypothesis:

> ***H3: As the digital age becomes increasingly entrenched, difference in survival between digital and non-digital firms will be reduced.***

Research Method

To understand the effect the internet has had on digital versus and industrial firms, we studied firm survival on the S&P 500 Index. This index maintains a list of the firms with the highest market capitalization in the two major U.S. stock exchanges (NYSE and NASDAQ). Therefore this is essentially a list of the most successful large, publically traded firms in the U.S. each year. In exploring the duration of firm tenure on the list, we can gain insight into the relative survival of firms in general over time, and thus test our hypotheses using survival analysis techniques.

Data

The data used in our empirical analysis comes from a set of annual company observations obtained through Wharton Research Data Services (WRDS). The database contains company information (i.e. company name, ticker symbol, SIC code, date of company foundation), basic financial indicators (i.e. revenue and market capitalization), and rank on the S&P 500 index. Entries span from 1963 to 2016. Since each company comes from the S&P 500, our research focuses distinctly upon companies with the largest market capitalization—the indicator that ranks companies on the S&P 500. The company listings are observed in a continuous stream without gaps.

SIC	TITLE
3571	Electronic Computers
3572	Computer Storage Devices

3576	Computer Communications Equipment
3575	Computer Terminals
3577	Computer Peripheral Equipment, Not Elsewhere Classified
7370	Computer Programming, Data Processing, Etc.
7371	Computer Programming Services
7372	Prepackaged Software
7373	Computer Integrated Software Design
7374	Computer Processing and Data Preparation Services
7375	Information Retrieval Services
7376	Computer Facilities Management Services
7379	Computer Related Services, Not Elsewhere Classified

Table 1. Standard Industrial Codes used for Identifying Digital Firms

The data set contains 1,409 individual companies from 300 industries. Furthermore, to classify digital firms, we identified SICs that are relevant to information technology (IT) and digital industries. Subsequently, using each company's SIC code, we cross-referenced a compiled list of digital and IT-related SIC codes for a complete dummy classification. The entire list of SIC codes used in our classification can be seen in Table 1.

Empirical Approach

In testing the first hypothesis, involving whether firms of any sort are indeed surviving for shorter durations, we use OLS approach and relate the year of company creation to the duration of firm survival before and after the internet revolution in the 1990s, mediated through firm revenue and the date of firm foundation. Our model has the following structure:

$$SPDur = \beta_0 + \beta_1 SPYear + \beta_2 Revenue + \beta_3 Foundation + \varepsilon_1$$

where *SPDur* denotes the duration of company survival: the difference between year of company foundation and its exit from index. *SPYear* represents the year that companies first entered the S&P index. We also included in the regression equation two control variables: *revenue*, the company's averaged revenue across all years that it remained on the index, and *foundation,* the year of company foundation, to account for the potential effects that the size and the age of the company has on firm survival respectively. As WRDS did not contain firm foundation information, we utilized company records to gather the necessary information.

In testing hypothesis two - whether digital firms should survive for a shorter term than non-digital firms – we analyzed the data over our entire data set (1963 to 2016). For hypothesis three, we postulate that the difference in the survival duration between digital and non-digital firms should reduce in the Internet era (post-1990) due to the change in competition structure across all industries as an effect of the information age. To test hypotheses two and three, we use the Cox proportional hazards model (CPHM) survival analysis. The CPHM is one of the most flexible regression models, available in many types for survival analyses. When compared to a parametric proportional hazards model, the CPHM produces very efficient estimates (Efron, 1977). Uniquely, it does not require the specification of the model's distribution. In calculation, each individual observation's hazard function is scaled by an unspecified baseline hazard function. Therefore, the baseline hazard function is an arbitrary and non-negative function in time (Fuentelsaz, Gomez, Polo, 2002). If $X_i(t)$ is the vector of covariates for the ith individual at time t, the model assumes that the hazard for a subject takes the following form:

$$\lambda(t; z_i) = \lambda_0(t)\, r_i(t)$$

where, $r_i(t) = \exp(\beta\, z_i(t))$ is classified as the hazard ratio for the ith subject, β is a vector of regression parameters and $\lambda_0(t)$ is the baseline hazard function. The model's constant term is not contained in the generally written form, but is instead embedded within $\lambda_0(t)$, which we do not define. The maximization of the partial likelihood function can produce the constant contained within $\lambda_0(t)$ (Cox, 1975).

Our model involves discrete data, rather than continuous. For this reason, a model that accounts for ties (ie. two or more hazards are observed simultaneously) must be implemented. Data is often recorded in units of days, months, and, most commonly, years. Accordingly, since our data is recorded in units of years, instances where data exit the index at the same time but may not exit simultaneously if more precise units were utilized, ties, are repeatedly confronted. Ties are not accounted for in the initial model proposed by Cox, thus posing a problem. Fortunately, there have been multiple forms of corrected CPHM models that circumvent this obstacle.

The first alternative is a method proposed by Cox (1972) which suggests the use of a logistic regression for robust approximation. This method is initially attractive since the result will converge upon the true Proportional Hazards Model as the time units of measurement shrink smaller and smaller (Thompson, 1977). Unfortunately, the methods taken by Cox (1972) does not adequately account for grouped data or data with many ties (Prentice and Gloeckler, 1978).

The second and third alternatives used to circumvent the existence of ties are more useful and applicable to our model. The second method, created by Prentice and Gloeckler (1978), comes directly from the Proportional Hazards Model and automatically assumes that the data is divided into intervals, accounting for ties. The analysis is then run using maximum likelihood estimation. The third method of extension was proposed by Breslow (1974) and Efron (1977). When ties do exist, the Breslow (1974) and Efron (1977) method seeks an accurate approximation of the partial likelihood function when the data's discreteness does not necessarily allow for such a perfect estimation.

The choice made for our model is contingent upon our data containing relatively few ties. Data containing relatively few ties is best estimated using the partial likelihood method (Fuentelsaz, Gomez, Polo, 2002). Thus, the methodology proposed by Breslow and Efron is most compatible for our compiled data. In another instance in which our data had significantly more ties, the maximum likelihood technique would have been more appropriate for estimation (Fuentelsaz, Gomez, Polo, 2002).

Results

We provide descriptive statistics and correlations in Table 2. As shown in the table, correlations between the two independent variables were relatively low. We also estimated the variance inflation factor for the regression model and it was well below 3.5. Thus, we conclude that multicollinearity does not pose to be a problem in the analysis (O'Brien, 2007).

Variables	Mean	S.D.	1	2	3	4
1. Survival duration (year)	29.701	0.423				
2. Year of S&P index entry	1975.559	0.388	-0.574*			
3. Firm revenue (US$ x10^6)	5205.721	294.462	0.144*	0.083*		
4. Firm foundation year	1941.040	1.268	-0.280*	0.417*	-0.081*	
5. IT firms (dummy variabl	0.069	0.007	-0.144*	0.228	-0.003	0.207*

n = 1,409

Table 2. Descriptive Statistics and Bivariate Correlations

In Table 3, we report OLS and CPHM results. Model 1 is an OLS regression result and model 2 to model 4 shows CPHM analysis results. Hypothesis one postulates that companies on the S&P 500 index survive for a shorter duration now than in the past. As shown in model 1, the regression coefficient for the year of S&P index entry is negative and significant ($\beta = 0.603$, $p < 0.001$). This finding empirically confirms that the duration of time firms remain in the S&P index is negatively related to the year that firms enter S&P index. In other words, newer firms that enter the S&P index later are more likely to exit the S&P index as compared to the firms that enter the S&P index earlier. This empirical finding supports the hypothesis 1 that the duration of firm survival is less over time.

Hypothesis two indicated that digital firms should survive for a shorter duration than non-digital firms overall. As shown in model 2, the hazard ratio for digital firms is found to be 1.587 and this coefficient is significant at the $p = .001$ level. This finding implies that digital firms are 58.7% more likely to exit the S&P index to non-digital firms over the span of our data. Thus, the alternative hypothesis two where digital firms survive for a shorter duration is supported.

Hypothesis three indicates that the dichotomous industry classification (digital or non-digital) will have a minimal impact after the turning point of the Internet. Again, using Cox Survival Analysis and the Breslow method for ties, hypothesis three was tested. Splitting the dataset at 1990 and testing all companies that existed before and including 1990, we find that the dummy variable classifying companies as digital is found to be significant at the p = .01 level and has a hazard ratio of 1.4834 (model 3). Thus, before the internet age, digital firms were 48.3% more likely to exit the S&P 500 each year than non-digital firms. However, after 1990, we find that the digital firm dummy has a p-value of .386 and a hazard ratio of 1.1493 (Model 4). Digital firms are therefore only 14.9% more likely to perish than non-digital firms in the post 1990 time period. Importantly, this coefficient is not significant which indicates that as the economy transitions to the digital age, digital firms and non-digital firms face similar rates of hazard. Consequently, hypothesis three is fully supported.

Variables	(1) OLS	(2) Cox proportional hazard model	(3) Cox proportional hazard model Pre-Internet era	(4) Cox proportional hazard model Post-Internet era
Year of S&P index entry[1]	-0.603***			
	(0.024)			
Digital firms		1.587***	1.483***	1.149
		(0.170)	(0.219)	(0.185)
Revenue (x10^{-4})	2.601***	0.999***	0.999***	1.000
	(0.29)	(0.000)	(0.000)	(0.000)
Foundation year	-0.007	1.001***	1.001***	1.002
	(0.007)	(0.001)	(0.001)	(0.002)
Constant (x10^{3})	1.232***			
	(0.441)			
R^2	0.367			
Adjusted R^2	0.366			
Log-Likelihood		-8,937.995	-6,682.542	-1,568.270
No. Observation	1,409	1,409	1,089	320

Note: Standard errors in parentheses [1] Year firms entered the S&P index * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3. Survival Estimation Results

Discussion

This study has two general sets of findings. First, we explore how during the transition to the digital age, innovation will proceed at a faster pace and that this pace will be different for digital and non-digital firms. Second, we investigate how difference play out once the digital age is becoming firmly entrenched. Next we will briefly reflect on these two sets of findings.

Transitioning to the Digital Age: Faster Innovation and Digital Firms

We have long understand that innovation is happening at a faster pace with the introduction of widespread digital technologies (Yoo, Lyytinen, Boland, & Berente 2010; Brynjolfsson & McAfee 2014), but this study validates this observation using a survival analysis of large firms. This finding validates many of the often anecdotal insights into the pace of innovation and adds to the large-scale empirical research that has similar findings (albeit measured in different ways, for example, see: Anthony, Viguerie, Schwatz & Landeghem 2018).

More than this, however, we distinguish between those firms that are fundamentally digital and those that are not. This is an important distinction. For instance, consider the development of a company that conducts business largely independent from the Internet, such as McDonalds. It is not expected that these Internet-independent firms will face heightened competition or that their business processes will be revolutionized by the introduction of the Internet – until they somehow become disrupted. Until that disruption, they face industrial age competitive forces. Conversely, for firms whose business is largely dependent upon the Internet and digital technologies, such as Apple, for instance, these firms continuously battle at the expanding and developing frontier of digital competition. They both face competitive environments, but because of the reduced barriers, combinatorial innovation, and open-ended generativity of digital technologies, the digital firms face a qualitatively different situation. Understanding the effects and differences between the two types of firms has implications for whether large digital firms are strengthening their hold on markets in which they compete, or, conversely, if non-digital firms are more fully strengthening their vice on non-digital markets.

We find clear evidence that digital firms face a much different competitive environment throughout the bulk of our study, and they perish at a faster rate than non-digital firms. This finding is not surprising given that digital firms compete squarely in the most tumultuous and dynamic competitive environments, with reduced barriers to entry and hyper-competition (Grover & Kohli 2013; Hirt & Wilmott 2014). The transition from the industrial age to the digital age increasingly lowered the batter to entry and further triggered the faster pace of innovation and thereby shorten the lives of both the digital and non-digital industrial firms. Nevertheless, the finding of this study confirms the idea that digital firms competing in comparatively more turbulent industry environment tend to survive for shorter duration than non-digital firms. This is clearly related to the imperatives of their competitive environment. However, this distinction may be losing its salience in the digital age – a situation explained by our notion of "field convergence."

Field Convergence

The emergence of the Internet combined with the availability of high performance processors in the 1990s revolutionized industries and enhanced consumer-firm interactions (Sampler 1998; Jorgenson 2001). In a sense, the 1990s marked a turning point ushering in the digital age. In the digital age all firms are in some degree digital firms. While a variety of scholars have highlighted this observation in a number of ways (Zammuto, Griffith, Majchrzak, Dougherty, & Faraj 2007; Yoo, Boland, Lyytinen, & Majchrzak 2012; Bharadwaj, El Sawy, Pavlou, & Venkatraman 2013), in this study we found evidence for this through firm survival.

We found that when the data was divided pre-1990 and post-1990, the negative relationship between digital and non-digital firms only held for the pre-1990 sample. For the post-1990 sample, the hazard rate for the digital firms became non-significant as compared to the hazard rate of non-digital firms. This finding confirms that particularly in the era since the widespread diffusion of the Internet, all firms must build digital capabilities and implement digital strategies (Sambamurthy, Bharadwaj, & Grover 2003; Karimi & Walter 2015; Bharadwaj, El Sawy, Pavlou, & Venkatraman 2013; Grover & Kohli 2013). All firms are therefore in this way similar to each other – regardless of their industrial category. These findings pose serious implications for understanding the dichotomy between firm competition in the information technology industry and non-digital industries.

We refer to this phenomenon – where the distinction between digital and non-digital firms decreases over time – as digital field convergence. In using the word "field" we distinguish digital domains of practice from previous industrial categories of organizations (Fligstein & McAdam 2015). In the industrial age, firms were contained in categories of similar practices and limited choices of business models according to well-established templates. In the digital age, there are no such industrial barriers. Among largest lodging and transportation companies are digital firms with no hotels or no cars. Uber and Airbnb have more in common with each other than they do with Yellow Cab Taxi or Marriott Hotels. Firms from previously distinct industries such as retail, banking and health care are all interested in customer experiences, insight from data, and the management of online platforms and mobile applications. Industries are losing their salience and the notion of field convergence captures this important element of the digital age.

Key Limitation

One key limitation is that our research database only contains companies with the highest market capitalization for their respective years. For this reason, our data is only representative of large firms and cannot be applied to smaller and medium sized firms. In addition, as this dataset shows, only those firms that have been most successful in terms of the market capitalization while surviving on the index, companies unable to achieve as highly may face separate competitive barriers preventing them from attaining as high of achievement in their respective fields. Instead, the situation could be different and those smaller companies face different circumstances that create a distinct level of competition.

Conclusion

We are no longer in the agricultural age. We are no longer in the industrial age. We are in the digital age. Of course, agriculture and industrial manufacturing are still very important, but the rules of the game are changing. In his seminal work on post-industrial organizing, Huber (1984) indicated that as we move past the industrial age, competition will be based on more and increasing access to knowledge, more and increasing complexity, and a faster pace of innovation all rooted in the capabilities from digital technologies that will affect firms of sorts. In this paper we find empirical evidence for this view and further conceptualize the notion of field convergence as an alternative to industrial-age categories.

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