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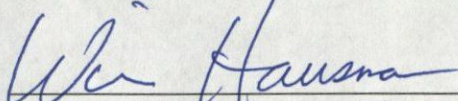
A thesis submitted in partial fulfillment of the requirement
for the degree of Bachelor of Arts in Economics from
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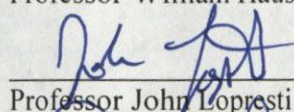
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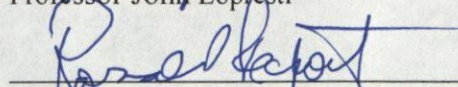
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Introduction

For decades now Silicon Valley has been the capital for major US technology firms and has become a thriving ecosystem for innovation. Household names in tech ranging from Apple to WhatsApp continue to drive innovations that improve or replace today's major industries and business practices. Although many start-up companies fail to gain traction or widespread success, a handful of companies have risen to world-wide success and multi-billion dollar valuations at a pace never before seen in business history. The well-known social media company Facebook has built a value of over \$245 Billion dollars and the car service phone application Uber has seized a notable share of the taxi cab market although neither company existed 12 years ago. These rapid innovations and a general culture of innovation are overthrowing well-entrenched incumbents and revamping the structure of a diverse array of markets. Large, successful firms that fail to adapt their products, business models, and strategies will inevitably decline at the hands of small disruptive competitors. Destructive innovation, however, is not a new concept. Technological advancement has been the cornerstone of growth for most economies and particularly for the United States for hundreds of years. Disruptive innovation and growth leads to the reallocation of value amongst firms within any given sector and between the sectors of the greater economy.

This paper will investigate the prevalence of modern day creative destruction in the context of the firms and sectors of the Financial Times 500 United States rankings from 1996-2015. The Financial Times 500 list, which ranks companies by market capitalization, will function as a new data source and a new framework for investigating creative destruction and growth in the US. Few, if any, previous studies have used the Financial Times dataset as a macroeconomic

analytical tool. I also aim to discuss the following questions regarding rapid firm value changes: Do firms grow faster today than they have historically, and what traits are crucial for their successful growth? Do new technology based firms grow faster than non-technology based firms? I will present recent evidence of Joseph Schumpeter's concept of creative destruction at work within several sectors of the US economy. The first two sections of this paper address the creative destruction and growth theories along with previous empirical works utilizing US corporate ranking indices. Part three discusses the methodology of the Financial Times lists and data collection/manipulation. The empirical segments of this paper begin with part four and progressively increase in specificity of creative destruction from general macroeconomic turbulence to individual firm growth. Part four examines the turnover rate of the Financial Times US 500 as a proxy variable for turbulence amongst the most valuable US companies. Part five delves into sector specific net changes in rankings and valuation on the FT US 500. Part six singles out the growth rates of new technology based firms and is followed by further discussion and conclusion.

I. Theory: Creative Destruction and Firm Competitive Interactions

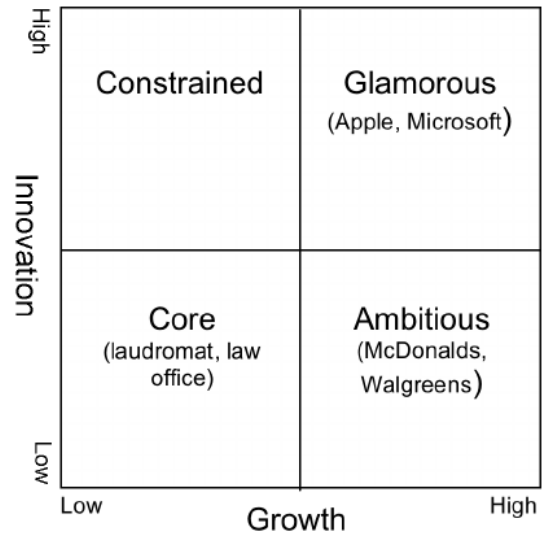
The Austrian economist Joseph Schumpeter coined the term "Creative Destruction" in his 1942 book "Capitalism, Socialism, and Democracy", describing the economic transition spurred by new technological innovations that replace old firms, products, and methods. He claimed this process of creative destruction was a central factor for growth in capitalist economies. These

technological innovations have historically destroyed the market presence of incumbents while rapidly seizing the consumers, market power, and profits of the decaying incumbents.

On the evolutionary yet necessary nature of creative destruction, Schumpeter stated in his book, “Capitalism, then is by nature a form or method of economic change and not only never is but never can be stationary.... The opening up of new markets, foreign and domestic, and the organizational development... illustrates the same process of industrial mutation- if I may use the biological term-that incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one.” (Schumpeter, pg83) The concept extends from Schumpeter’s inquiry into the Marxist critique of capitalism’s constant destruction of capital. Schumpeter’s vision of the process of creative destruction is embodied in both macroeconomic growth theory and industrial organization theory.

Technology has commonly been cited as a crucial factor in macroeconomic growth in many economic growth theories ranging from Malthusian growth, the classical growth theory, to the Solow-Swan model. All claim that technological advancement fuels growth. Modern growth theories have investigated the sources and causes of technological change. Much of the propagation of innovation through the economy is most apparent in firm behavior, competitive decision making, and metrics associated with industrial organization such as market share breakdown and firm ranking. The classical process of technological disruption originates with small, high technology and high growth firms (as we will discuss is empirically true later). Several authors have attempted to establish a framework for growth through innovation. Kirchoff (1994) established a four-part typology of innovation for small firms based on growth rate and innovation. The typology helps isolate the role of technology and the small firm in dynamic

capitalism and creative destruction. Kirchoff distinguishes high growth firms between high and low innovation. This innovation distinction holds crucial implications for firms' growth rates.



II. Previous Works and Literature Review

In hopes of better understanding the presence modern creative destruction, I will examine a number of previous works that have explored Schumpeter's ideas on firm behavior and the role of market turnover in the macroeconomy in a variety of contexts. The two most relevant criteria for use of previous works are the similarity of experimental structure and similarity of subject matter. Similarity of experimental structure confines previous works to the use of index-based metrics or relative corporate ranking based papers. The relative ranking index most commonly utilized to investigate a variety of trends in the American economy is the Fortune 500 family of

¹ Kirchoff, B. (1994). *Entrepreneurship and dynamic capitalism: The economics of firm formation and Growth*. Westport, CT: Praeger Publishers.

lists published annually by Fortune magazine. The Fortune 500 list, first published in 1955, ranks US and global corporations based on their total revenues. The Fortune list is frequently utilized as a snapshot of the relative value and influence of the largest companies in the United States. The prestige that accompanies the accolade of “Fortune 500 Company” is understandable given the total value of all the companies on the list was \$17 trillion in 2015 (the Financial Times US 500 companies was \$19.86 trillion that same year). Economists began to incorporate the index as an empirical framework for Schumpeter’s creative destruction and turnover in the American economy (Kirchhoff, 1990). The Fortune ranking began to paint a more complete picture of the American business landscape as it grew in age and became a resource for economists to examine the changes that occur over the span of decades within that business landscape. Just as I utilize the dropouts/newcomers to the volatility and the makeup of the most powerful American corporations, William Shanklin demonstrated that two-thirds of the 1955 Fortune 500 list members had departed over the course of the first 30 years of the list’s publishing and the inevitable engine of change in capitalism remained alive and well (Shanklin, 1986). The survivability of companies on the Fortune ranking was correlated to the degree of innovation present in each firm. Technology and entrepreneurship were crucial to competitiveness of long-lifespan companies. Tremendous resources allocated to research and development, along with a creative and entrepreneurial spirit present in corporate leadership were the attributes that proved most beneficial to companies in long-run survival measurements. Robert Simonetti (Simonetti, 1996) was one of the first to use the Fortune list from 1963-1987 to investigate the mobility and turnover of firms within an individual industry (industrials) as well as the collective influence and mobility of sectors on the greater Fortune list.

When utilized, a focus on relative firm position has provided empirical evidence of creative destruction in the macroeconomy where an individual firm or sector specific framework failed to. By pegging individual firms or industries to a relative ranking index, such as the Financial Times list or Fortune list, we can isolate the relative changes attributable to technological development and the accelerating growth that follows. The arrivals and departures from a generalized ranking system allow for inter and intra-industry analysis. Although their approach is Industrial Organizationally centered, Mazzucato and Tancioni (2005) prove through examples of automobile and personal computing industry examples that the destruction caused by technological innovation produces an uneven effect on firms and industries visible in ranking systems but is not discernible in individual market systems. The most significant periods of innovation in many industries occur shortly after industry formation leading to the seizure of market share by a handful of early innovators and industry exit for technological laggards.

The second category of previous works worth noting are those on the subject of the study of Schumpeterian Creative Destruction in modern contexts and the role of technology in creative destruction. The reallocation of resources within industries and within economies is commonly a product of creative destruction through the entry of new firms or industries. The American economy has, in the past 50 years, welcomed the digital revolution and the information age and with it the rising tide of new technology-based firms. Most research, however, has neglected to include these NTBF's and start-ups in discussions of modern creative destruction. This is in part due to their small size, although the technologies they produce have radical implications for industry turnover. Kirchhoff and Spencer (2006) attempted to establish a framework to incorporate NTBF's as the primary drivers of Schumpeter's phenomenon. They build upon the notion that the size and growth rates of firms affect the caliber of the disruption that they pose to

markets. Small and high growth firms are the most likely to introduce radical disruption while large firms are more likely to introduce controlled, incremental technological disruption. Kirchoff and Spencer (2006) establish a clear link between process of NTBF industry disruption and the theoretical understanding of creative destruction. The process begins with the failure of incumbent firms to invest in technologically superior business practices and continue a standard practice while new technology based firms develop a threatening technological alternative. The technology of the NTBF originally applies to a small market share and grows gradually in efficiency. The NTBF then seizes the market as their technology surpasses the effectiveness of the incumbent.

Jovanovic and Rousseau (2006) note that the pace of NTBF entry can act as a function of general-purpose technology eras. General-purpose technology eras are long-term periods of innovative firm creation on the basis of a single generalized technological breakthrough. Much of our period of observation falls within the Information Technology GPT and the fastest growing individual firms we observe have exploited the revolutionary interconnectedness of information technology. The IT GPT era has allowed firms to generate wealth rapidly through web-based or mobile technology-based products and services.

A subsection of the 1995 annual “State of Small Business” report focusing on innovation within small American firms conducted by the US Small Business Association found that small companies were the most effective innovators. Although small businesses were only awarded 3.8% of federal research and development funding, they were awarded 38% of all patents in 1995. Small business private spending on research and development was only 14.5% of all private spending on R&D. Interestingly, Kirchoff and Spencer (2006) and the SBA annual report (1995) both cite pharmaceuticals and nanomaterial industries as likely candidates for

future radically disruptive technologies. We will later demonstrate empirically that these industries have achieved significant ranking gains on the FT US 500 list over the 10 year span since 2006. More recently, studies and policy papers surrounding “Start-ups” or small, recent-entry technology firms have demonstrated that between 1999 and 2006 an increased presence of innovative firms has chipped away at the average size of large incumbent firms (Derbyshire & Haywood 2009). Through the use of relative firm size bands, Derbyshire and Haywood measure the percentage of small firms increasing in size bracket and large firms shrinking in size bracket. Their model, however, is limited to size bands based on number of employees, which may not fully represent a firm’s growth. We hope to apply a similar technique on a larger scale with improved measurements of growth and firm value to demonstrate evidence of Schumpeterian creative destruction.

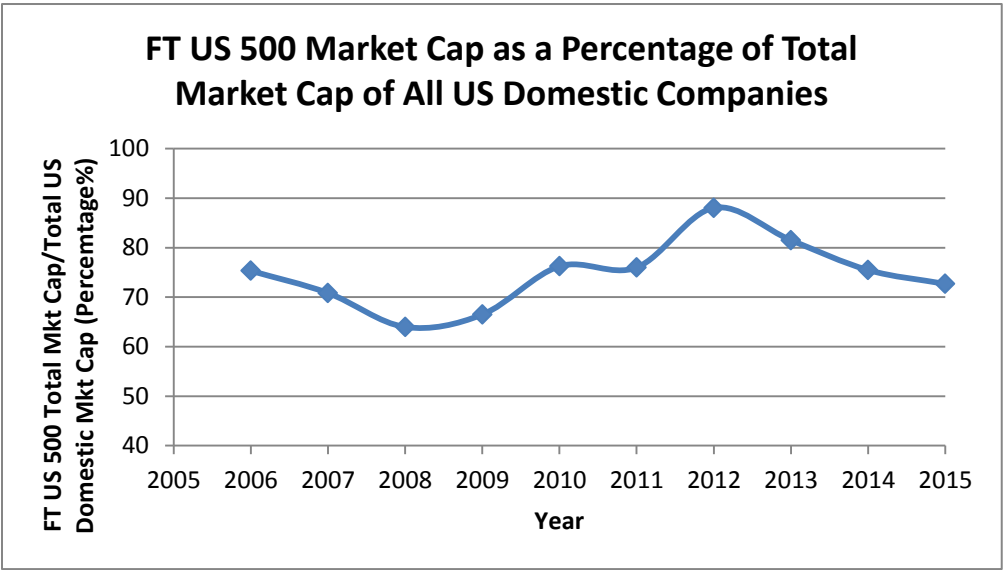
Firms touting new technologies rise rapidly within industries and capture market share and value. The rate at which this turnover within industries occurs is of particular interest because of its implications for macroeconomic stability and safety of investment. In their 2005 paper “Firm Turnover and the Rate of Macroeconomic Growth,” Eliasson, Johansson, and Taymaz claim the rate that firms enter and exit in simulation peaks at an optimal point. Through the use of an experimentally organized economy model MOSES, they demonstrate that growth is hindered as industry turnover rates due to entry of innovation surpass an optimal point. Beyond the optimal point, long-run destabilization occurs and mistaken investment decisions can occur due to rapid industry structural change. Their results are crucial to keep in mind as we isolate measurements for the rate of growth and wealth accumulation of modern technology based firms and the potential negative effects of accelerating growth.

III. Methodology

Nature of the Financial Times lists- In order to examine the major corporate players in different industries in the United States, I utilized the Financial Times United States 500 list published by the Financial Times newspaper. The FT US 500, not unlike the better known Fortune 500, is an annual list, published by the Financial Times newspaper, of publicly traded US companies ranked by order of market capitalization. The Fortune 500 list ranks the largest US companies by revenue. The Financial Times list, which has been published since January 1996, offers a context for the rise and fall of individual US firms. Apart from market capitalization, the FT US 500 also offers data on industry, turnover, assets, employees, net income, dividend yield, and p/e ratio. The list includes each firm's ranking from the previous year, allowing readers to understand firms' net rise/fall on the list over the year. The sector data points, which I will discuss later in more detail, allow us to understand trends in the fluctuations in the market value of industries of the American economy as well as the movements of individual competitors in each FT US 500 sector.

The influence of the FT US 500 companies on the American economy and the lives of everyday Americans is unmistakable. These companies represent the most valuable leaders of their respective sectors. Although the FT US 500 list represents only 1/8th of the 4000 publicly traded companies in the US, it represents more than 80% of the value of the US stock market. Despite small fluctuations, the FT list has represented approximately three quarters of the value of all of the publicly traded companies in the United States every year for the past ten years. The

list’s cumulative value is disproportionately affected by US market conditions. The list value suffered greatly during the 2008 Financial Crisis and saw significant gains in 2012-2013 market rallies. Aside from their sheer cumulative value, these companies have a significant impact on employment and local economies. This paper focusses predominantly on United States domestic based companies and indices, but it should be noted that the outreach and magnitude of FT US 500 companies are globally significant. US equities share of the global total market cap was 33% in 2014. Sitting at roughly three quarters of the US equities total market cap, the FT US 500 list would be more valuable than the next three major nations market caps combined (Japan, China, UK).



As noted previously, extensive work on creative destruction and growth has been conducted using the Fortune lists yet few, if any, studies have used the Financial Times US 500 rankings as a framework for exploring creative destruction or other macroeconomic phenomenon. Just as economists began to acknowledge the value in the Fortune list as an

investigative tool in the late 1970's after it had reached 20 years of cumulative data, I hope to uncover the maturing value of the Financial Times 500 lists as an analytical tool for recognizing the trends in macroeconomic growth.

a. Data Collection

The Financial Times Newspaper hosts data from its FT 500 Global, US, Europe, UK, Japan and Emerging categories on its website for the years 2006-2015. The dataset regularly includes the 500 companies ranked by Market Capitalization, rankings by sector, Newcomers, and departures. All data from 2006-2015 was accessible through FT.com with a subscription. Data during the years 2014-2015 was available for download in Microsoft Excel format which provided the formatting end-goal for further historical data 2013 and earlier. The FT US 500 lists from 2006-2013 were compiled by the Financial Times in PDF format with individual layouts varying year to year. Finally the FT US 500 lists from 1996-2002 were discovered, after extensive research, to be available exclusively on microfilm. Each microfilm edition of the list was located and compiled separately. The FT US 500 list from the years 2003-2005 was found to have only been published on the Financial Times' website and not presently maintained in any known database.

As previously noted and individually defined, data for each of the firms listed on the yearly FT US 500 included entries for present year rank, previous year rank, company name, sector, present year market cap, turnover, net income, total assets, number of employees, price, profit/earnings ratio, and dividend yield percentage. These 12 data points were consistently printed in the 2006-2015

editions of the FT US 500 lists while the 1995-2002 editions included a slight variation that excluded price, dividend yield percentage, and price/earnings ratio. Over 90,000 data points were collected from the Financial Times digital and print publications for use in this paper. In addition to Financial Times published data on the top 500 US companies, the relevant founding dates for newcomers to the list were collected from various sources to generate time dependent variables. Founding date of the original components of firms was utilized when no simple founding date could be found. For example: company A acquires a competitor, company B, and is subsequently founded with a new title/corporate structure; the original founding date of company A would be used for the surviving conglomerate of companies A and B.

b. Formatting

The dataset was compiled and manipulated in Microsoft Excel and further manipulated with Stata and Matlab software packages. The diversity of formatting of the historical FT US 500 lists from 1996-2015 proved to be a formidable challenge to any further manipulation of the data. Raw data in PDF format required the use of third-party software in order to convert to a Microsoft excel document. Converted PDF's required extensive revision to correct errors in data row alignment. The third party PDF-Excel conversion software products required further parsing as the older PDF lists hosted on the FT website existed only as older and more rigid files types. Long company names along with long significant

figures in quantitative data led to errors and improperly categorized data points that were resolved through manual corrections.

Partial data sets collected from the microfilm editions of the Financial Times from 1996-2002/6 had to be manually entered into Microsoft excel format. The microfilm editions limited the use of pre-2006 lists in cumulative value calculation and sector specific measurements.

c. Newcomers list and 2006-2015 Sector comparison

The process for generating the FT US 500 newcomers list for 2006-2015 required only a simple sorting function once the compilation of 2006-2015 lists had been completed. The process for collecting information on lists published from 1996-2006 had to be conducted manually.

The 2006-2015 Sector comparison segment utilized the entirety of the FT US 500 lists from 2006, and 2015. The comparison segment highlights the overall changes in value, relative sector valuation, and sector weight on the list. For both sections, we are predominantly interested in those firms that have entered, departed, or remained ranked during our 2006-2015 timeframe. Firms that have never reached the top 500 list by market cap can certainly operate successfully, but they remain outside of our area of interest. First, the market capitalization of all firms on the list was summed (operation

only performed on excel formatted lists). Second, the 2006 and 2015 lists were reorganized alphabetically by sector, and the market capitalizations for each company of every sector were summed and compared between years. Lastly, each pair of lists was organized alphabetically by sector and the numbers from each sector was summed from each year. The latter was then subtracted from the former to find the net change between years.

Net Sector Change From Year X to Year Y = $\sum(\alpha \text{ Sector Company, year X}) - \sum(\alpha \text{ Sector Company, year Y})$

Comparison of 2006 individual firm market capitalizations and cumulative sector market capitalizations were converted to 2015 dollars for comparison through the use of consumer price index data obtained from the US Bureau of Labor Statistics.

d. Growth Measurement Variables and Corporate Age

In the final segment of this paper, I will discuss trends in the growth of firms that have generated massive valuations in short timeframes. In order to isolate the fastest growing firms, we need to incorporate a measurement of relevant company age. To further limit the scope of observed firms in any given year, only the newcomers from each list year were included. This segment required research on each of the newcomers' founding histories. Many firms founding information was readily available through corporate history logs while many others required research on acquisitions, buyouts, and renaming. As noted in the Collection subsection, the founding date collected for a firm that

experienced a renaming or a merger was the date available for the larger original firm. Newcomer firms that later merged or underwent a buyout remain as part of the dataset for their list entry year as a separate entity. Each firm's market capitalization for its list entry was then divided by its corporate age to generate a value growth per year variable. Newcomers were then determined to be technology based or non-technology based. Technology determinations were established on the basis of sector. A small number of exceptions were made for firms with radically innovative business practices placed by the financial times in sectors considered to be non-technology based. Real estate investment trusts (REIT) were excluded from this segment due to their limited comparability to both traditional and technology-based companies. Double-entry firms or firms that entered, departed, and re-entered the list as newcomers were excluded from this segment in order not to double count their significance in technology's impact on growth. The first entries were included in calculations while any further entries were not included. It should be noted, however, that the proportion of double-entry firms was minor at only 4% of all newcomers.

The first metric of firm growth used market capitalization at the year of list entry divided by the firm lifespan at year of list entry. The average mkt-cap/lifespan for both the technology based and non-technology based groups for each list year. This method attempts to isolate the progress made by firms in their corporate lifespans. Entry to the FT US 500 functions as a "finish line" while market cap and lifespan function as a distance covered and time respectively. The resultant variable is "speed" at which firms have been able to reach the FT US 500.

The second metric utilizes the FT US 500 rank achieved by newcomers as a measurement of their significance relative to other ranked incumbents. Each new entry firm's rank was subtracted from 500 to invert the ranking system. The average ranks achieved for both the technologically based and non-technologically based categories were collected. A "rate of rank achievement" variable was also created by dividing rank at time of list entry by lifespan (located in Appendix 1B). Data was then visualized in terms of our created growth per year variable for further analysis.

A Note on List Limitations-

Utilizing the Financial Times US 500 lists as a metric for the examination of creative destruction and firm growth in modern context presents a variety of benefits as well as limitations. As previously noted, using the FT list allows for fairly convenient collection and manipulation of data. This data is also up-to date as of the year 2015 and include recent record-breaking companies and their ascension to global relevance. The Financial Times lists also experience a handful of limitations due to the nature of their ranking methodology and short span of publishing. The annual FT US 500 lists include only publicly traded companies listed on exchanges in the United States. The inclusion of only publicly traded companies excludes all forms of private companies. Although this exclusion is not negligible, most high value American businesses are public companies. Cargill, which was the most valuable private company as rated by Forbes Magazine, only had an estimated market capitalization of \$54 billion (as of 2011, would have placed it at number 49 on the FT US 500). The Financial Times utilizes the market capitalization of companies as a ranking methodology. Market capitalization, or the number of a

company's shares outstanding times the price per share, acts as a well-rounded metric for our purpose of comparing corporate fortunes and influence on the economy. The market capitalization metric lacks extensive depth beyond stock price into the source of corporate value and is then exposed to bias or mis-valuation stemming from market fluctuations. Other valuation methods, while comprehensive, would not allow for mass data manipulation. Lastly, the FT lists are fairly young and have only been regularly published since 1996. Although the young age of the Financial Times 500/FT US 500 (1996) compared to the older Fortune 500 list (first published in 1955) and the Standard and Poor's 500 index (computed and reported regularly in 1964) limits the chronological breadth, it will undoubtedly serve as an increasingly valuable metric as the Financial Times continues to publish the list in years to come. Although these limitations certainly do not significantly reduce the legitimacy of our findings, they set clear boundaries for the breadth of companies to be investigated and the scope with which they can be examined. It is nearly impossible to establish a metric that simultaneously allows for mass manipulation of corporate data and provides a perfect firm valuation.

IV. Newcomers to the Financial Times US 500 List

1996-2002:2006-2015

The "Newcomers" to the FT US 500 list or previously unranked firms making their first appearance on the list offer significant insight into the health and turnover of the American economy. By observing the newcomers to the FT US 500 list, we can highlight and better

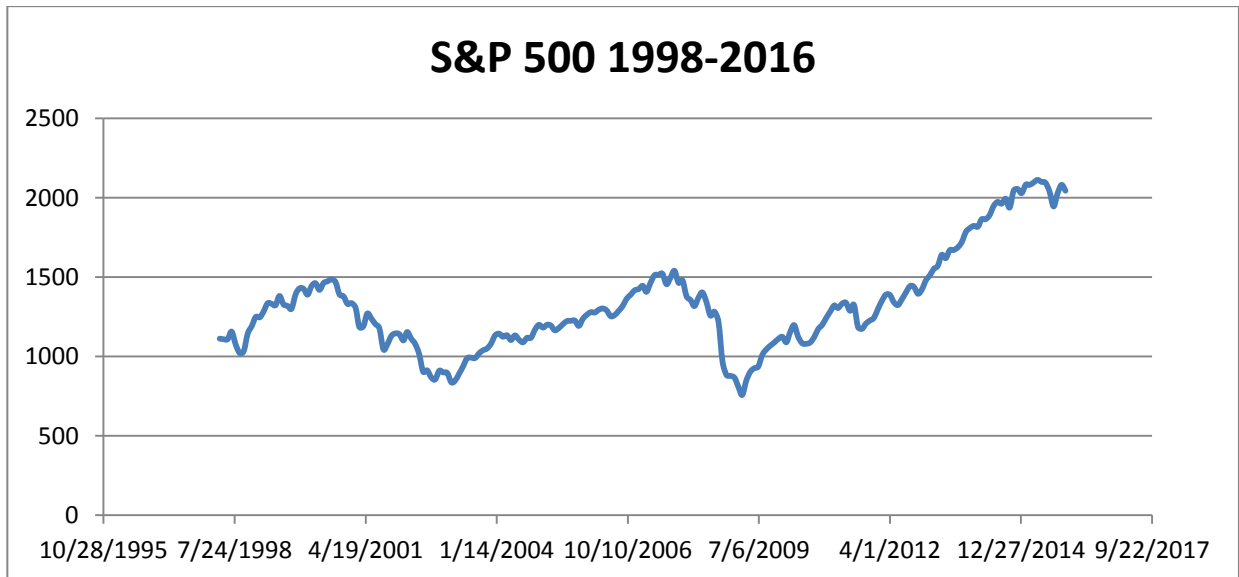
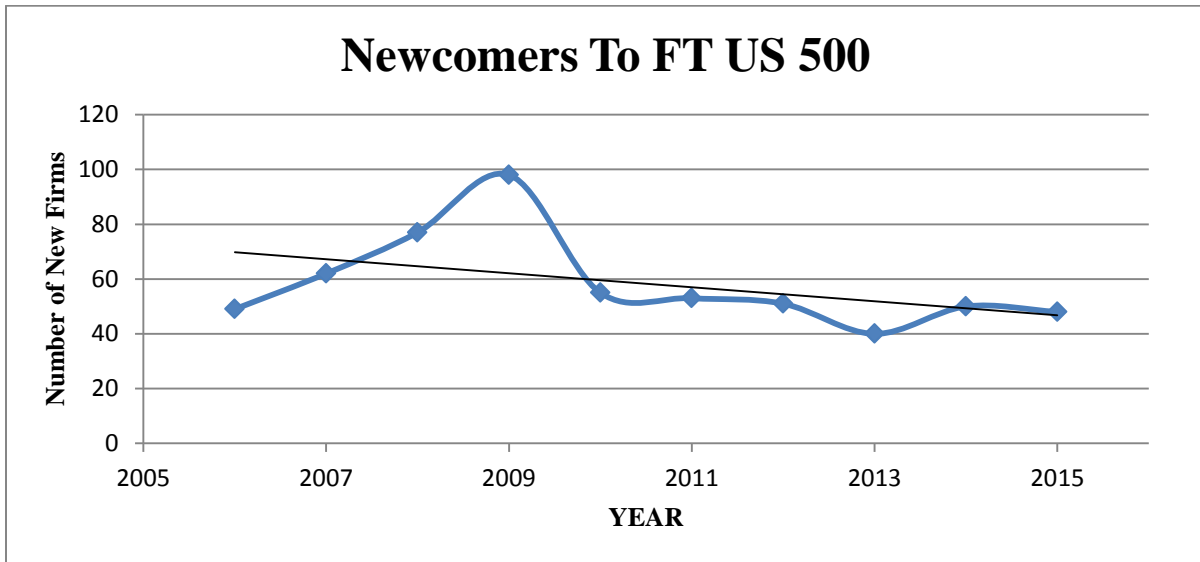
understand periods of historical turbulence for the most influential companies in the US. The newcomers represent the newest generation of large American businesses and the fastest companies to generate enormous value and power to shape the future of our economy. I will first discuss the annual number of newcomers every year, which simultaneously represents the “turnover rate” of the FT US 500. Given the finite nature of the list, the number of new, previously unranked, firms arriving on the list is equivalent to the number of previously ranked firms departing the list. The turnover rate functions as a bird’s-eye-view of the volatility and significant historical events of the American business landscape.

Over the course of the ten-year period of 2006-2015, the average turnover rate/newcomer rate was 53.2 firms per year. Over 10% of the top 500 most valuable companies in the US in any given year will not be ranked the following year. The turnover rate of the FT US 500 does not, however, function as an isolated proxy variable for any one macroeconomic phenomenon. Departing companies lose their ranking for a number of reasons, including mergers and acquisitions, market volatility, technological inferiority, and general loss of competitiveness.

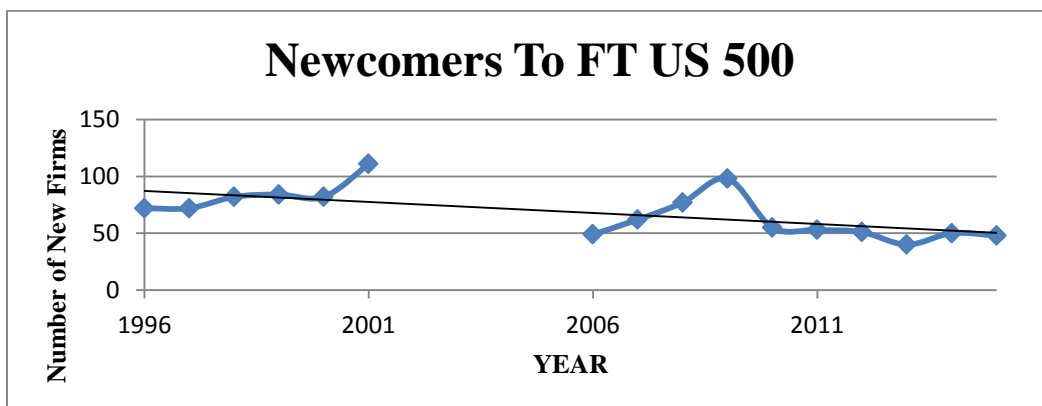
The evolutionary aspects of Schumpeterian creative destruction are evident in the numerous changes and notable volatility of the FT US list. Foster and Kaplan (2001) note that list departure and firm discontinuity are inevitable with time amongst the most valuable firms. Capital markets and indices are the arenas in which creative destruction is readily apparent. Capital markets and indices simply do not tolerate underperformance. They assert the notion that firms may reach the top 500 through innovation, but the assumption of continuity and drive for long-term performance limits their degree of innovation which subsequently leads to replacement through creative destruction.

(It is crucial to note the difference between corporate lifespan and lifespan on the FT US list.

Most companies continue to operate successfully for some time despite having lost their relative value and influence within their respective sectors.)



In compiling the turnover rates for the FT US 500 list from 1996- 2015, two periods of significant turbulence stand out 2006-2010 and 2001-2002. In 2006 the FT US 500 turnover rate sat at 49, very close to the 10 year average, but began a gradual increase in 2007 which peaked by 2009 at 98 departing firms. By 2010 the turnover rate had returned to 55. The timing of this change in the FT US 500 ranking coincides with the 2008 financial crisis. Many of the FT US 500 companies populate indices such as the Dow Jones Industrial Average or the Standard and Poor's 500 indices which, in 2008, experienced losses of value of 33.84 % and 38.49% respectively. (The FT 500 lists are published early in the title year so market losses experienced in 2008 and subsequent volatility on the rankings of companies by market capitalization would be reflected in the 2009 FT list.) The cumulative value of the FT US 500 list dropped 39% between the 2008 and 2009 list years. The massive decline in markets brought a disproportionate decline in various sectors of the economy, which I discuss later in more detail. The disproportionate decline in 2008 in sectors of the FT US 500 likely served as the basis for a shift in relative value/rank within the list. Companies in sectors less affected by the 2008 market decline and financial crisis overtook those more effected companies leading to an increased rate of departure from the list. The volatility of the top 500 list has been trending downward since the peaks during the 2008 Financial Crisis and remains around its all-time lowest levels.



The second notable anomaly in the history of the FT US 500 newcomers is 1999-2001. The first few years of the FT US 500 list (1996-1999) saw consistently high turnover rate of around 80 firms per year. In 2001 the turnover rate spiked to 116 firms per year. One possible explanation for this increase in volatility could be the significant market movements that occurred in the late 1990's/early 2000's. In 2001, the NASDAQ Composite index shed 39.39% of its value after experiencing massive growth in 1998 and 1999. This rapid rise and fall would be later known as the "Dot-Com Bubble". Many companies born following the popularization of the internet in the early 1990's had generated a sufficiently high valuation to place on the FT US list but promptly departed when their market cap's collapsed in 2000-2001. Another probable explanation for the record-high turnover rates of the late-1990's and into 2000-2001 is the mergers and acquisitions boom of the corresponding time period. Skeptics of the list turnover rate cite these alternative causes for list (M&A waves and IPO booms) as complicating factors in observing volatility. Although they may not fit a standard narrative of creative destruction as rise and fall or firm birth and death, these alternative explanations still exemplify creative destruction. The volatility that we have observed in list turnover rate captures a wide range of creative destruction firm activity. We have demonstrated the varying effects that significant market movements have on the most important firms in the US. However, Stangler and Arbesman (2012) note that the particulars of volatility are difficult to distill in a simple rate of list turnover. While overall list turnover describes the indiscriminate sum of all significant firm activity (firm gains/loses, M&A, IPO's), the evolutionary narratives of individual industries are obtained through the lens of list sectors. It is more realistic to evaluate firm level competitive decisions and industry concentration effects within instead of across sectors.

Figure. NASDAQ Composite 1996-2002



The 1999-2001 Dot-Com Bubble and 2008-2009 Financial Crisis were periods of significant change for the FT US 500 and the American economy. Of the original 500 firms on the Financial Times US 500 list published in 2006, only 321 firms or 64% of the list were still ranked in the top 500 by 2015. In less than a decade, more than one in three of the top 500 companies in the United States departed the Financial Times US list. We will dive deeper into this turbulence to observe how particular companies and sectors weather disruptive innovation, competition, and financial crises.

v. Sector Growth: Financial Crisis and the Return to Tech

2006-2015

Now that we have discussed the trends in general volatility of the FT US 500 through observation of list turnover rate, we can investigate the individual drivers and victims of innovation on a smaller scale. One of the major advantages of a relative corporate ranking model is inter-sector comparability. The reallocation of wealth between sectors of the FT US 500 is indicative of the sectoral changes in the economy over time. We would expect to see a transition of value from older traditional sectors towards new technology based sectors. A net change in the number of firms per sector listed on the FT US 500 over time is potentially indicative of market concentration changes.

Jovanovic and Tse (2007) note that shakeouts within industries or early departure of unsuccessful competitors can occur while sector capacity continues to grow. We will observe this case within particular sectors of the FT US 500 despite increased market concentration. I will utilize both net-position change and cumulative value variables to unpack sector dynamics. I will first address the sectors with list position net-losses and potential explanations for their sector decreases in ranked positions. I will then address the sectors that have experienced the most significant net position gains over the past ten years.

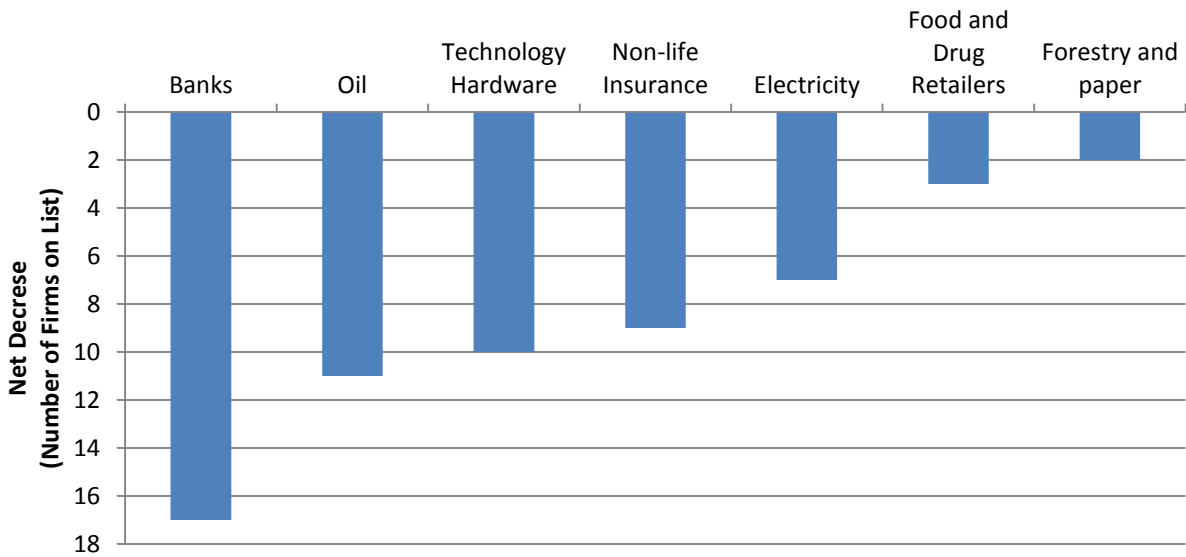
The most significant change amongst all of the gaining and declining sectors between 2006 and 2015 was the decrease in the number of firms on the FT list experienced by the US banking sector. Banks, which held 32 ranked positions in 2006, held only 15 ranked positions by 2015; a loss of over 53%. The US banking industry was disproportionately affected by the 2008 Financial Crisis leading to increased mergers and acquisitions thus loss of ranking slots.

Departure from the FT list rarely occurs due to bankruptcy or default, but the Financial Crisis brought some of the most notorious corporate failures in decades. Even more telling than the decrease in bank positions held is the sector's decrease in cumulative market capitalization over that same time period. The banking sector's cumulative market capitalization experienced a 24.3% decline from \$1.44 trillion dollars in 2006 (adjusted to 2015 dollars) to \$1.09 trillion dollars in 2015. Similarly, the non-life insurance sector declined 37% percent in its representation on the FT US 500 although it experienced close to no change in market capitalization. The minor change in value of the US insurance sector over the course of 2006-2015 demonstrates the industry's buffer from the losses experienced by the banking sector. Steeper competition and post-crisis reforms have forced insurance companies to consolidate or streamline business practices thus we have seen an increased M&A within the industry despite limited market capitalization loss.

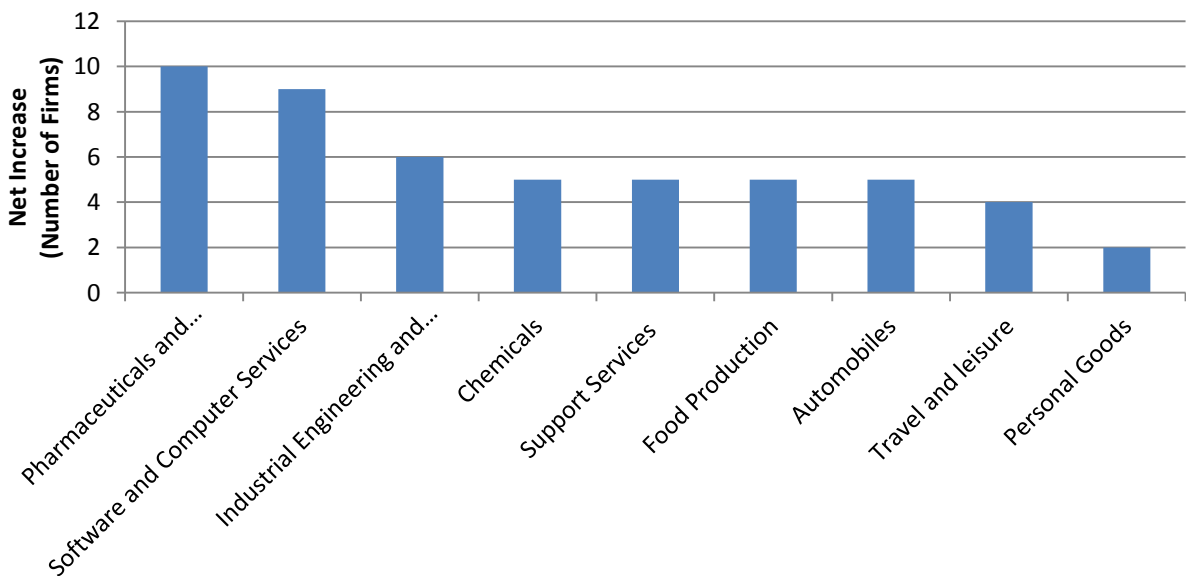
The Technology Hardware sector of the FT US 500 is perhaps the most representative of creative destruction of any sector on the list. Technology Hardware saw a 25% decline in ranked positions on the list but experienced an astronomical increase in value of \$1.2 trillion dollars from \$481 billion in 2006 to \$1.69 trillion in 2015. Household technology names such as Advanced Micro Devices (AMD) and Dell departed the list after stagnating business practices led to massive market cap declines and privatization in Dell's case. The computer producer Hewlett-Packard lost nearly 50% of its market cap while Intel's market capitalization experienced a modest growth of 10.5%. The true model performer and innovator of the Technology Hardware sector, however, was Apple. Apple's market cap in 2006 was \$54 billion (\$63.72B in 2015 dollars) and 724\$ billion by 2015; over a 1000% increase. Of the \$1.2 trillion expansion in value of the Technology Hardware sector, Apple accounted for slightly more than

half with its \$661 billion increase in valuation. Apple's introduction of new innovative consumer electronic products like the Ipad (2001), Iphone (2007), Ipad (2010), and Apple Watch (2014) have been an engine of growth for the company. In 2006 Apple's \$19 billion in revenue was less than that of Microsoft, Sony, Dell, Nokia, and Blackberry by margins of 30%-300% but by 2015 Apple's revenue had reached \$234 billion, more than Microsoft, Sony, Dell, Nokia, and Blackberry's combined revenue. Apple's research and development spending has exploded from \$780 million in 2006 to \$8.1 billion in 2015 and is consistently rated one of the most innovative large companies in the world. In discussing firm short term performance and research and development spending, Swift (2008) notes that a steady commitment to R&D funding regardless of performance leads firms to the greatest success. Modern creative destruction is likely born in the R&D lab or in the creative mind of the entrepreneur. Apple has become the most valuable company in American history, rising from #74 in 2005 to #1 by 2012, because of its disruptively innovative products and creative approach to consumer electronics. It is simple to see creative destruction at work in the Technology hardware sector. In ten years, constant innovation drove a relatively minor market participant to seize a near sector majority and forced a quarter of its competitors off of the FT US 500.

Net Sector Decreases on FT US 500 From 2006 -2015



Sector Net Increases in FT US 500 2006-2015



The FT US 500 sectors with net position gains represent the winners of the evolutionary process of creative destruction. The ranking positions vacated by bulky incumbents and declining technology business are filled by quickly growing companies most valued by investors and everyday Americans. The reallocation of corporate fortunes from list incumbents to newcomers over time demonstrates the constantly changing dynamic of a healthy economy.

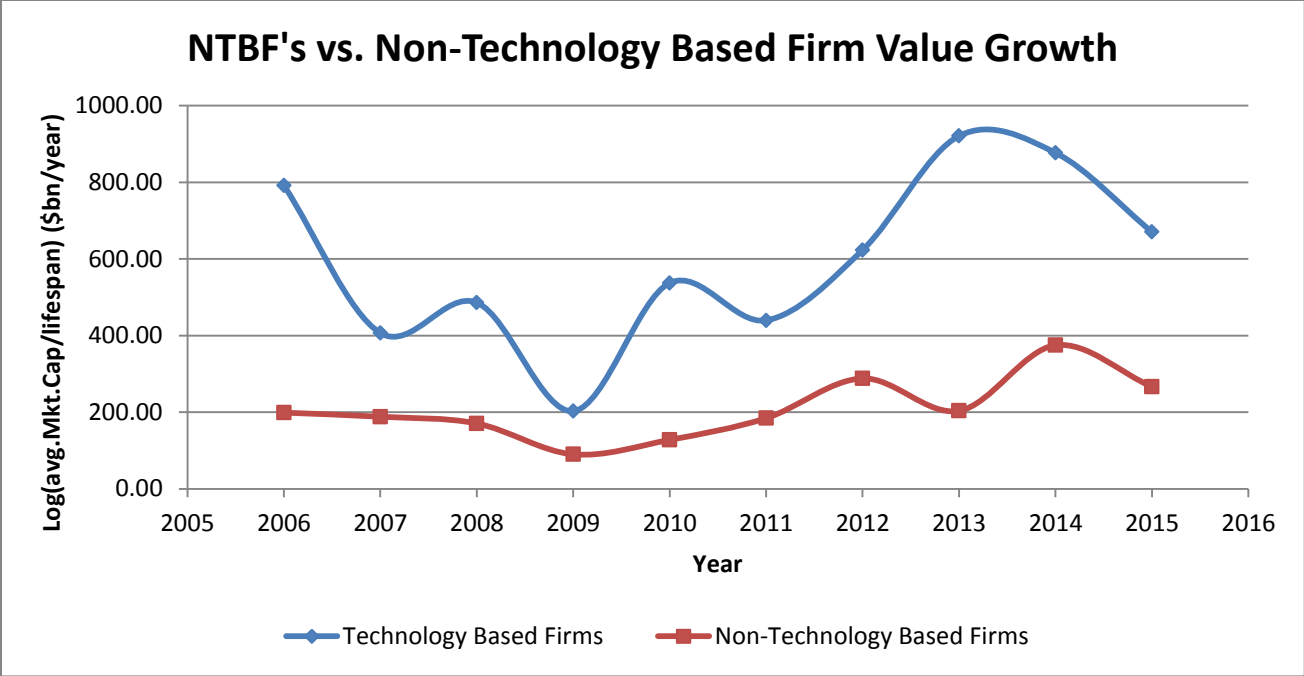
The major gains made over 2006-2015 were predominantly in the Pharmaceuticals, Computer software and Services, and Industrial Engineering. Other notable position gains occurred in the Chemicals, Support Services, Food Production, and Automobile sectors. Pharmaceuticals acquired 10 positions or a 48% increase from 2006. Pharmaceuticals also increased \$941 billion in cumulative market capitalization from \$986 billion to \$1.93 trillion (a 96% increase). A significant portion of the 2015 pharmaceuticals sector including Endo, Incyte, Jazz, Abbvie, Medivation, Hospira, and Pharmacyclics Pharmaceuticals were all founded after 1990. The net increase in list positions for the pharmaceuticals sector demonstrates decreased market concentration with an entry of a greater number of potential competitors of varying sizes. The relatively young age of many of its constituent firms and explosive valuation of the pharmaceuticals exhibits the industry-wide growth potential of technologically innovative sectors.

The Computer Software and Services sector made the second most substantial gains in terms of number of ranked companies. It is crucial to differentiate the Computer Software and Services sector from the Technology Hardware sector for the sake of understanding their respective growth and decline. Computer Software and Services includes companies that produce non-standalone computer elements (ie. microchips and processors), computer software (ie. operating systems), and web based services. The emphasis within the Computer Software

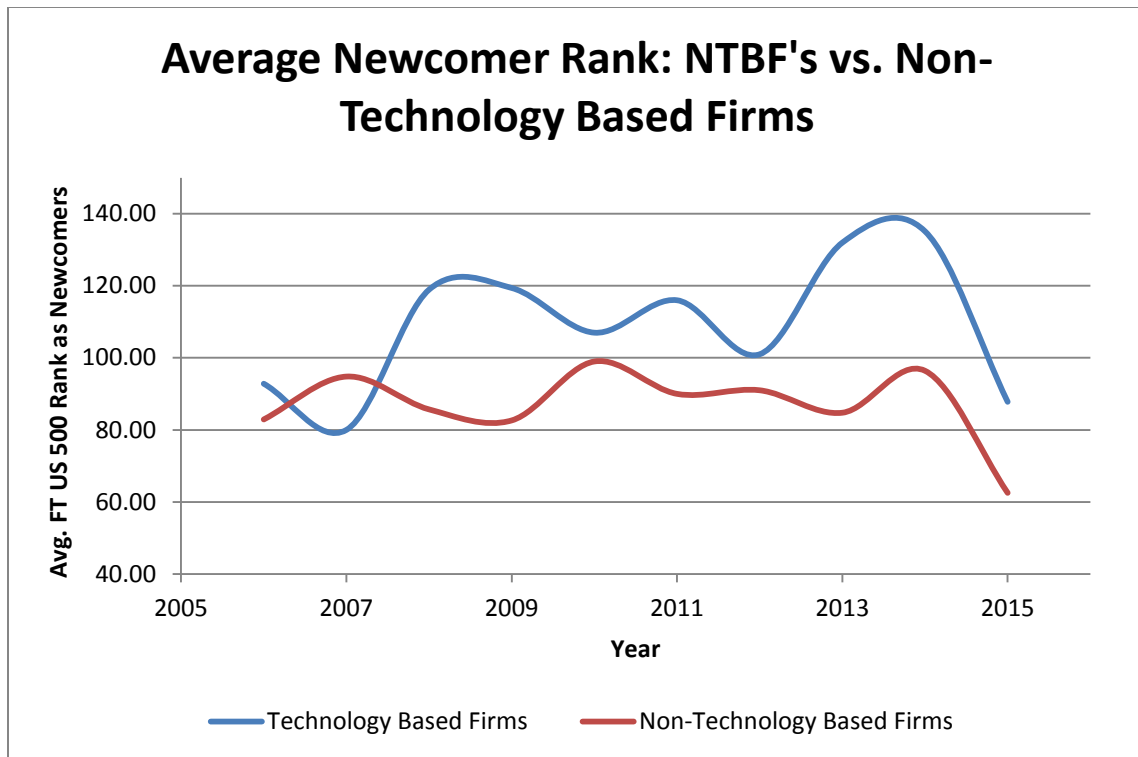
and Services is on non-physical products. The Technology Hardware sector includes both companies that produce standalone personal computers and companies that produce computer components. Computer Software and Services saw a 53% increase in ranking positions and an 89% increase in real cumulative sector market capitalization. Notable market incumbents Microsoft and IBM both experienced minor gains (~10%). Smaller market incumbents (those that had been ranked in 2006) saw significant success over the course of 2006-2015. Oracle increased in real market capitalization from \$82.5 billion to \$188 billion. The web based search engine Google, rose to the most valuable company in the Computer Software sector with a 265.4% increase in real market cap. Google doubled its share of the Computer Software and Services sector value from 10.5% to 21%. Younger and smaller firms like Twitter and Palo Alto Networks, both new to the FT US 500 list in the past three years, serve as model NTBF's. Rising to ranks 149 and 384 respectively, these firms have capitalized on developing technology and the network effect present in many information age technological products. The Computer Software and Services sector has consistently housed some of the fastest growing firms of the past decade due to minimal barriers to entry and rapid propagation of information based products and services. We have seen the progressive growth in rankings and value made in the technologically based Computer Software and Services sector as well as the Pharmaceuticals sector. Within the framework of the FT US 500, Technology hardware has increased in market concentration with a select handful of firms seizing market share while cumulative sector value has skyrocketed. Meanwhile, the more traditional Banking and Insurance sectors have yet to recover from the 2008 Financial Crisis and the destruction of value that ensued. It is immensely valuable then to examine the differences in growth between technology based and non-technology based firms. Our next segment focuses on the effects of technology on growth rates.

VI. Growth and Wealth Creation in FT US 500 Technology Firms

In our discussion of the FT US 500 sector changes we noted the rise of technology based incumbents in the Technology Hardware and Computer Software and Services sectors. In this section we explore the growth characteristics of all new entry firms over the course of 2006-2015. Unlike the previous section that considered the net sector changes of incumbents and new entrants, this section considers only new entrants. We are particularly interested in the comparison of technology based and non-technology based new entry firms. Our time dependent growth variable (market cap)/(lifespan) allows us to isolate any differences in growth of innovators and traditional firms. In fact, our first growth metric demonstrated a notable difference between the market-cap/lifespan rates of new technology based firms and non-technology firms. As seen in the figure below and in appendix (1A Table 1.), technology based firms grew by an average of \$401.2m/year more than non-technology firms. The effects of the Financial Crisis and market recovery are present in both tech and non-tech firm trends. A dramatic increase in average technology based firm growth not present in non-technology firm growth in 2013 is likely the result of a number of high-profile, high value initial public offerings. However, the technology category growth rate remains around two to four times the growth rate of the non-technology based category.



Our second growth variable, Average Newcomer Rank, also demonstrated a gap between NTBF's and non-technology firms. Technology based firms were more likely to enter the FT US 500 list at a higher rank and position of greater significance than non-technology firms. The average NTBF entered the list 22 ranking positions higher than non-technology firms. While a difference of 22 ranking positions may seem insignificant at first, it represents a nearly \$1 billion dollar difference in valuation. It should be noted that, unlike market cap growth per year, average rank among newcomer firms is independent of firm lifespan. Technology firms seize more market cap value and relative significance through the process of creative destruction than their traditional firm peers independent of corporate age.



Conclusion

Thus far we have investigated the presence of modern creative destruction amongst a new dataset of the top 500 firms in the United States by market capitalization in three tiers of specificity. Our first and most general tier observed the turnover rate of the FT US 500 list from 1996-2002 and 2006-2015. We found the turnover rate following a general downward trend despite two periods of increased firm entry and exit during the Dot-Com Bubble and 2008 Financial Crisis. The turnover rate attributable to a host of causes including firm value changes, mergers and acquisitions, and large initial public offerings, while useful for understanding the landscape of the collective FT US list, was unable to isolate underlying individual industry changes. Our second tier utilized the net sector change in positions held along with cumulative

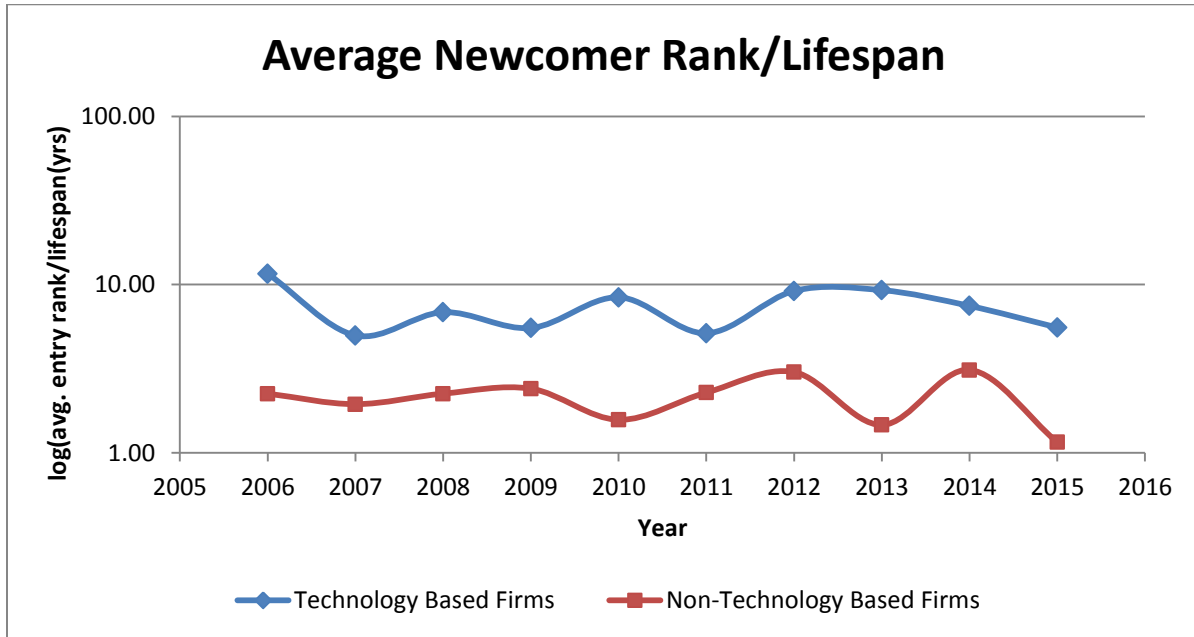
sector market capitalization value to understand changes in market concentration, growth, and creative destruction present in the individual sectors of the FT US 500. Traditional sectors, particularly Banking and Non-Life Insurance, suffered net position decreases over the past decade along with cumulative value stagnation or loss. Significant evidence of creative destruction was present in the Technology Hardware and Equipment sector (producers of consumer electronics) as the market concentration of the sector increased dramatically while the cumulative sector value nearly quadrupled from \$481 billion to \$1.69 trillion led by the growth of a handful of innovative firms. We have discovered that technology based sectors have built a larger and growing presence in rankings on the FT US 500 list since 2006.

Finally, our analysis of the growth of Technology-based vs. Non-Technology-based FT US 500 newcomers found that innovative firms accumulate market capitalization faster than non-technology based firms. Technology firms also enter the FT US 500 at higher-ranking positions than non-technology based firms. Disruptively innovative firms on the FT US 500 are the drivers of growth and Schumpeterian creative destruction within the list and the economy. Our sector examination was limited to the most volatile sectors, but the Financial Times lists offer valuable data on major market actors in over 37 other sectors of the US economy. Pharmaceuticals, internet-based startups, and semiconductor companies should be investigated in greater depth to better understand the distinguishing traits of successful NTBF's. Further examination of the Financial Times list, as an analytical tool, should be conducted as the list accumulates more years of data.

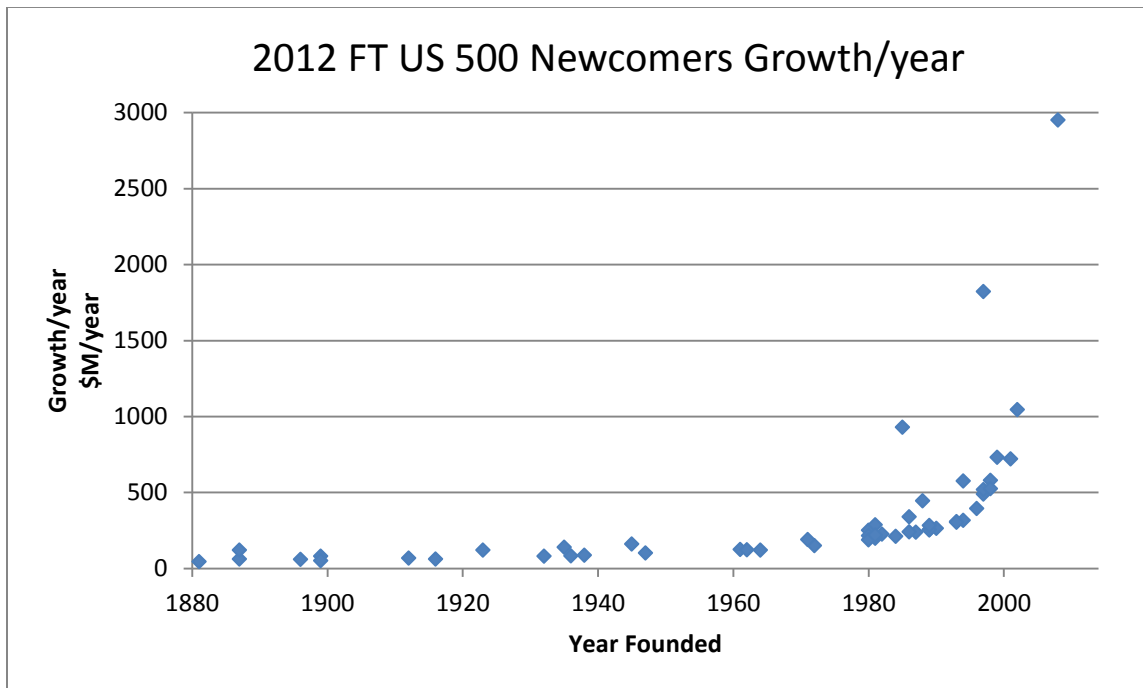
Appendix 1A.Table 1

Year	Tech Average Growth	Non-Tech Growth	Tech Average Rank As Newcomers	Non-Tech Rank As Newcomers	Tech Average Rank/Year Existence	Non-Tech Average Rank/Years Existed
2006	791.97	198.87	92.82	82.9	11.62	2.25
2007	406.73	188.10	80	94.81	4.99	1.95
2008	485.96	170.61	118.94	85.69	6.85	2.25
2009	202.90	90.05	119.41	82.64	5.52	2.41
2010	537.24	127.78	107.00	99.00	8.41	1.57
2011	439.76	184.39	116.00	90	5.14	2.28
2012	623.18	288.09	101	91	9.17	3.02
2013	1069.17	203.58	166.83	84.76	9.27	1.47
2014	876.99	374.66	135.14	96.42	7.47	3.11
2015	670.46	266.35	87.8	62.52	5.56	1.16

Appendix 1B. Figure 1



Appendix 1B. Figure 2



Outliers: Groupon and LinkedIn

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