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BOOM AND BUST: JOB CHURN IN THE TECHNOLOGY INDUSTRY IN THE COVID-19 PANDEMIC ERA

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By

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Abstract

Layoffs in the technology sector since 2021 have dominated news cycles and raised concern amongst everyone, from investors to employees. However, there is limited literature regarding the reasoning behind these layoffs and whether they really are as concerning and dramatic as our modern-day news has expressed. In this paper, I examined the historical trends of employment and contributing factors and discerned that the current wave of layoffs has occurred for a few reasons. In the past, the technology sector has been very strategic with hiring and only does so when revenue permits. However, during the pandemic, the technology sector became overzealous by their potential demand and technology craze and therefore overhired when revenue did not permit such. Hence, these findings aid the discussion that the COVID-19 pandemic entered unprecedented waters and is one to continue investigating.

Acknowledgments

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Specifically, Professor Van Horn and Professor Kacher, you both have been the best advisors throughout this process, pushing me to think deeper about my questions and think outside of the box. I am so grateful to have had both of you as constant resources for me throughout this thesis; your guidance has made this process as smooth and enjoyable as possible.

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I. Introduction

Employment in the technology sector is worthwhile to investigate as it offers a more comprehensive picture of the sector's success as a whole. Before the COVID-19 pandemic began in 2020, job churn followed a relatively linear pattern and did not raise much concern. However, the industry took a turn during the pandemic, and layoffs reached unprecedented levels. According to Layoffs.fyi, a site that has been tracking tech layoffs since COVID-19, found that in 2022, 1,052 tech companies laid off 161,411 employees. Furthermore, there is no sign of a slowdown, as so far, in 2023, 527 tech companies have laid off 153,548 employees (Layoffs.fyi 2023).

The overarching reason given by CEOs, analysts, and everyone in between for the 2021-2023 layoffs, is generally that firms overhired; however, the rationale beyond that is sparse. Therefore, these layoffs are an attempt to reduce costs and improve profitability for a company or the industry as a whole. For example, Yamini Rangan, the CEO of HubSpot, a Software as a Service (SaaS) sales and marketing company, explains this belief in an email sent to all HubSpot employees regarding the layoffs on 31 Jan. 2023. She wrote, "We grew headcount faster than revenue in a number of teams. We were optimistic about our headcount growth and underestimated the impact of the slowdown in 2022" (Rangan 2023).

Despite these press releases, there is little in-depth academic literature regarding the root cause(s) of these layoffs from an analytical and data-driven perspective and whether they are as drastic as the press and other viewers have made this phenomenon out to be. Therefore, this paper will examine the causes leading up to layoffs on an industry-wide scale as well as specific big tech firms, focusing on the top 11 companies with the greatest number of layoffs to date.

The question driving this paper is, how are firms in the technology industry making layoff decisions? Is it purely based on the macroeconomic business cycles caused by the effects of the COVID-19 pandemic, or are there microeconomic trends also at play, considered through productivity and revenue? Should we be concerned with these layoffs happening day in and day out?

The independent variables of employment in the technology sector that I will explore in this paper are interest rates, revenue, productivity, and wages, on both an industry-wide scale as well as company specific. Also, to note, all of the companies examined in the information sector are publicly traded companies only.

II. Literature Review

As aforementioned, layoffs in the technology sector dominate the news cycle. On any given day, after searching "tech job layoffs," results list articles from Bloomberg, Forbes, The Wall Street Journal, and the Economist, amongst many others, all published within the previous week. However, when it comes to academic literature and publications, the information remains limited. One aspect that is especially lacking is the historical context. We can investigate the current phenomenon as closely as we want; however, to fully understand it, we must look at past employment performance in the technology sector to contextualize the current layoffs. Nonetheless, there are a few valuable sources to highlight in this paper.

The first is the article "Information technology personnel layoffs in US Organizations: An exploratory investigation" by C. Ranganathan and Kedar Samant, 2005. In this article, the authors investigate the trends in information technology (IT) personnel layoffs across different industries, their nature and extent, the reasons for downsizing, and the financial environment of

firms laying off IT workers. To accurately explore IT layoffs, they look at 569 layoff events in the US between 2000 and 2001. The authors collected this data from public announcements about the layoffs made by specific firms. Ranganathan and Samant use Firm closure, Performance issues, Economy-related, M&A, Business refocus, Restructuring, and Others as their independent variables. They then compared these variables against specific industries within IT. Using a general linear model analysis, they showed that around 50% of the layoff events involved a reduction in the IT workforce in the range of 10–30%, and the extent of the reduction in IT labor was almost identical across the industries. Regarding the reasons for layoffs, the authors found that performance (cost-cutting and productivity) was the top reason. When examining their general financials, they saw that these firms had significant problems controlling costs, so the firms downsizing IT workers were less cost-efficient than their industry counterparts.

Next, the authors, John Haltiwanger, Ian Hathaway, and Javier Miranda, wrote the article "Declining Business Dynamism in the US High-Technology Sector" in 2014 to examine whether the recent trends of declining business dynamism and entrepreneurship across a broad range of sectors in the US economy apply to the US high-tech sector as well. To conduct this investigation, they use job creation and destruction in young and older firms as variables. The authors find that the pace of business dynamism has declined in the high-tech sector post-2002. Further, not only has it declined, but it has slowed at a pace that exceeds that of the overall economy. They find this conclusion potentially concerning as they consider young high-tech firms might be even more critical for innovation and new job creation than their non-high-tech counterparts.

Thirdly, the article “Is Structural Unemployment on the Rise?” by Rob Valletta and Katherine Kuang from 2010 demonstrates that cyclical factors account for the rise in the unemployment rate rather than a lack of the necessary skills. They show that, through the Beveridge curve, structural unemployment and the Non-Accelerating Inflation Rate of Unemployment (NAIRU) increase during and after a recession. So, the relationship between unemployment and vacancies, shown in this curve, is consistent with the increase in the NAIRU. NAIRU is a useful measure as it tells us how much ‘spare capacity’ there is in the economy for employment and that the inflation rate should increase when the unemployment rate goes below the NAIRU level.

Subsequently, Xuan Wang, Yaojie Li, Thomas F. Stafford, and Daqi Xin explore the current IT labor market in their 2021 article titled “The IT Labor Market Amid the Pandemic: The Case of the United States.” They explore the IT labor market from July through December 2020, the height of the COVID-19 pandemic. They believe this data to be extremely relevant, as it indicates how firms decide to hire employees in the midst of a tumultuous time. With this data, they perform descriptive analysis and logistic regression to understand further how the severity of the pandemic relates to remote versus on-site work, work schedules (part-time versus full-time), and organizational sectors (commercial versus government versus nonprofit). They found that all work arrangements were turbulent, and the IT workforce prioritized work from home. Based on their data, they expect to see a rebound in the technology sector labor market and even see it perform better than it has been in the long run.

The 2007 article “Do Layoffs Payoff? An Empirical Investigation of Financial Impacts of IT Worker Downsizing” by Poornima Krishnan, Christina Outlay, and C Ranganathan investigates whether the recent massive layoffs of IT workers have generated any economic

returns or performance improvements. To tackle this question, the authors focus on the post-layoff financial performance of IT firms. They break down layoffs into two categories, strategic and tactical. Strategic is defined as "Core competence, access to new markets, increase competitive advantage, and mergers/acquisitions." In contrast, tactical is defined as "Cost reduction, boosting revenue, and responding to poor market returns." They also consider the variables, the size of the layoff, Financial Performance (Profit and cost ratios), firm industry, and firm size. In this study, the authors find that IT firms do not improve their overall financials by downsizing IT workers. As they show, in the two years that followed a large round of layoffs, profit ratios continued to be negative, and cost ratios continued to be positive. Further, the firms that laid employees off for a strategic reason saw better performance than those who did it for a tactical purpose. Lastly, they see that the size of the layoff does not impact post-layoff financial performance. Therefore, their main takeaway is that they should retain and nurture IT workers instead of laying them off.

Next, in the article "When Are Layoffs Acceptable? Evidence From a Quasi-Experiment" by Gary Charness and David I. Levine, they investigate the question of what is perceived as a fair layoff and what is perceived as unfair. They looked at employees in Silicon Valley and Canada to get a broader range of opinions. Charness and Levine explored the factors of shock, declining product demand, new technology, employees' suggestion, and the project ended. They saw that layoffs due to lower product demand were perceived as fairer than those that occurred due to employee suggestions. Further, the respondents showed that new technology was a somewhat legitimate reason for a layoff. Lastly, layoffs were perceived as fairer if the CEO shared the pain.

In the article “Analysis of Reasons for Layoffs by Technology Startups during Covid-19 Pandemic,” published in 2021, Sekhar Chebolu discusses the reasons for layoffs in the technology industry. He asserts that many technology startups’ layoffs had a lot less to do with the Covid-19 pandemic and, instead, were a way to shed non-core businesses, eliminate layers, terminate lower performers, and tighten their profitability. He shares that in his research, he found that many of these prioritized retaining employees, and therefore, these firms had an extensive runaway of capital. However, the pandemic became somewhat of an excuse to realign the business, separate from the pandemic. The benefit that the pandemic offered these layoffs was that it forced companies to provide more generous severance packages. Overall, the author stresses that employees, especially in the tech sector, need to be aware of the value they are adding to the firm to be prepared for layoffs that are a part of the business restructuring of tech companies.

The authors, Doh-Shin Jeon and Joel Shapiro, wrote the article “Downsizing and Job Insecurity” in 2007 about why firms vary substantially in their downsizing efforts. They consider the factors, magnitude, timing, one-time massive cut vs. waves of layoffs, and zero layoff policies. They show how managing job security is imperative to a sense of productivity at a firm, especially in the face of an uncertain economic climate. However, firms must also balance that with laying off redundant workers. Further, zero layoff policies signal that the firm is optimistic about its future.

The article “The Importance of Startups in Job Creation and Job Destruction” by Tim Kane, written in 2010, explores how tech startups are some of the largest job-creating firms in the economy. He highlights a concept that I am also trying to debunk: the media often inflates tech layoffs and creates more commotion around them than needed. Instead, Kane shows how

net employment growth shows the life cycle of job growth in tech can be extremely useful for policy making. Using Business Dynamics Statistics (BDS) data, Kane shows that in the first year of firms' lives, they create an average of 3 million jobs. Therefore, when it comes to policy making, an effective policy to promote employment growth must include a significant consideration for startup firm creation.

Lastly, "The Flow Approach to Labor Markets: New Data Sources and Micro–Macro Links" by Steven J. Davis, R. Jason Faberman, and John Haltiwanger is an extensive article written in 2006 that investigates the relatively current-day labor market through the flow approach. The flow approach states that worker flow is: hires minus separation, and job flow is: creation minus destruction, and the two end up equaling one another. They have a few conclusions using the Bureau of Labor Statistics and the Census data. The first is that the lump theory of employment is inaccurate. The lump theory establishes that there is a fixed amount of work to be done in the economy. They show that over two-thirds of job destruction happens at organizations that downsize by more than 10 percent within the quarter, and more than one-fifth occurs at those that shut down. Secondly, the study asserts that there is a very nonlinear relationship between worker flows to employment growth and job flows at the micro level. They show how there are recurring cyclical patterns in aggregate labor market flows. Lastly, they demonstrate that there is a loose micro relationship between hires and layoffs in severe downturns in the job-loss rate.

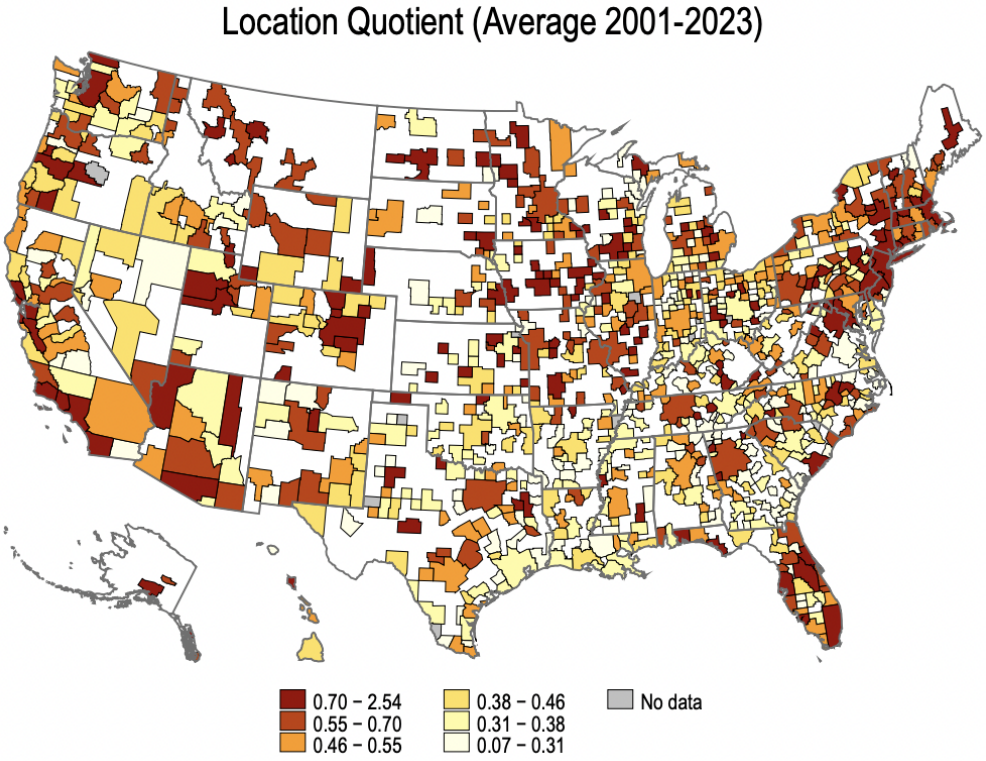
III. Data

A. Regional Description

To further understand how the information industry operates, I investigate the regional breakdown of employment across the United States. I use the data from the Quarterly Census of Employment and Wages (QCEW) produced by the US Bureau of Labor Statistics (BLS). BLS collects this data from a few sources, such as the Quarterly Contributions Report (QCR) from all private sector employers and state and local governments covered under the unemployment insurance (UI) program. Additionally, BLS conducts two surveys of approximately one-third of all private-sector US businesses.

Figure 1 shows a map of the location quotient (LQ) averaged across quarters from 2001 to 2023. LQ for the information industry tells us the percentage of people employed in that sector in the specific county divided by the percentage of people employed in the information industry nationally. The LQ helps us see how concentrated the technology sector is across the country and, therefore, can tell us what locations could have been more impacted by these layoffs.

Figure 1



Source: QCEW by BLS

As visible, the West and East Coast have the highest concentrations of technology sector workers. This is not very surprising as both the Bay Area and New York/Boston areas are two of the largest hubs of technology in the United States. Therefore, these regions may have been more affected by the layoffs due to the pandemic.

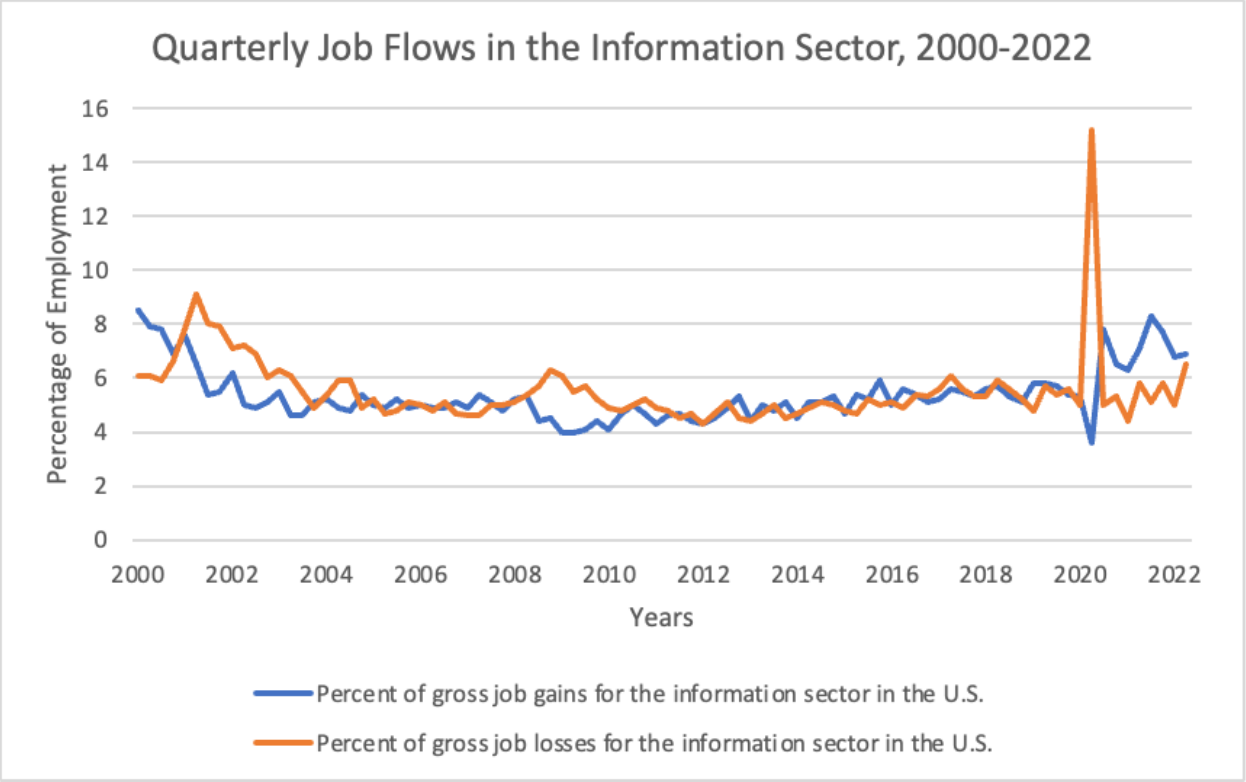
However, many of the impacts of these layoffs were mitigated by the fact that so many workers are remote in the technology sector. This data uses company-reported data; therefore, the information about employment and LQ will include all employees where the company's headquarters are, not where individual employees are based. Further, a study completed by

Revelio Labs found, “Since March 2022, over 70% of laid off workers have been able to find a job within the first three months of unemployment” (Ozdenoren 2022). Therefore, even though layoffs may have impacted the local economies briefly, given how resilient the labor force is in the technology sector, it most likely did not have too lasting of an impact. As a result, this data offers preliminary background information to understand the technology sector on a regional scale and where business cycles in the technology sector have the most considerable impact.

B. Industry-Wide Descriptive Background

In order to understand layoffs in the technology sector, industry-wide patterns need to be understood. This is especially true for patterns established by historical data, as it offers a way to gauge the current layoffs and if they align with trends or are deviating. To begin, Figure 2 shows the quarterly job flows starting in 2000 up until 2022.

Figure 2



Source: BLS Business Employment Dynamics (BEDs) data

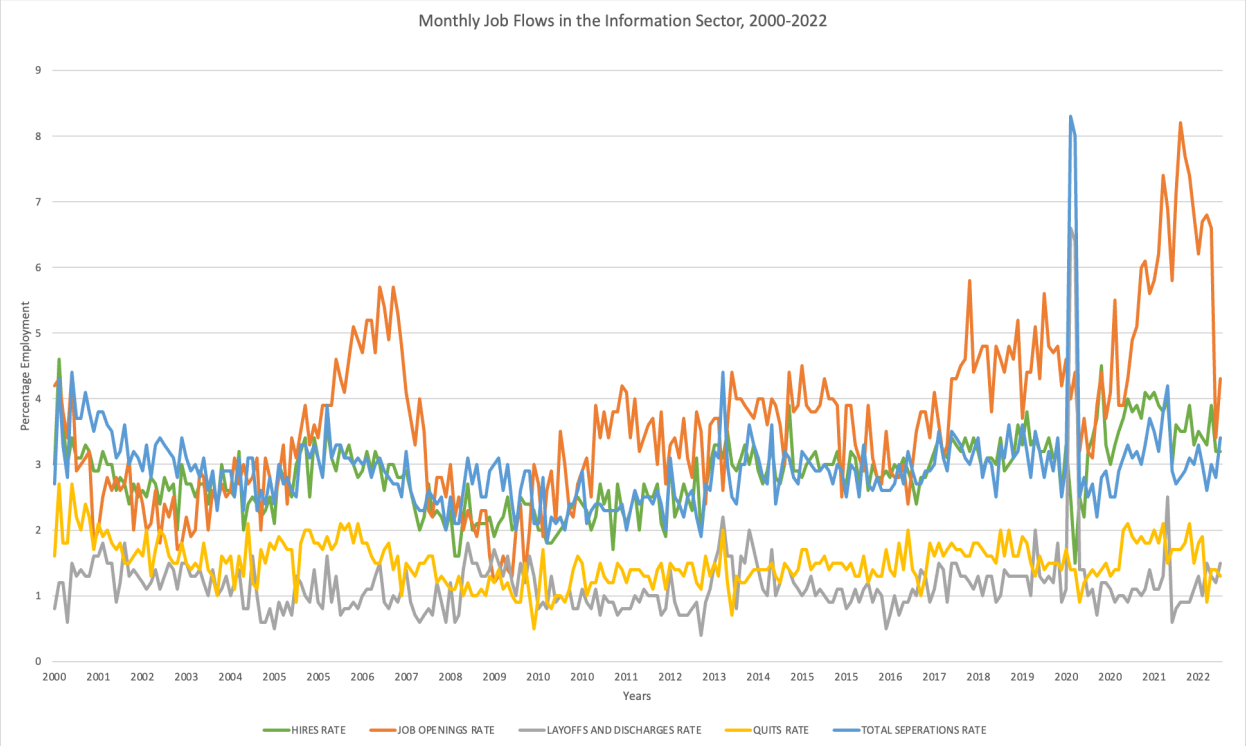
Data for Figure 2 was collected by the Bureau of Labor Statistics (BLS). They sourced this data from the Quarterly Census of Employment and Wages (QCEW) program, which includes information about all establishments subject to State unemployment insurance (UI) laws and Federal agencies subject to the Unemployment Compensation for Federal Employees program. It is estimated that it covers around 98% of all employment.

This graph helps contextualize the historical trends of the information sector starting in 2000. To help understand this graph, it is useful to consider the economic concept of job churn. Employee churn is defined as the difference between existing employees losing their jobs and new ones getting hired. As visible in the graph, job churn has remained relatively stable and low,

as the number of job gains and job losses track alongside one another. Of course, there were minor differentiations throughout time to note, such as the 2010 recession that did cause job losses to increase and therefore churn to do so too. However, the information industry saw the most aggressive changes during the pandemic, as job losses skyrocketed, and therefore, churn also jumped. Then, moving to a post-pandemic era, the industry's overcorrection is visible, as the jobs gained overtook the jobs lost by the most significant amount since 2000.

Figure 3 helps add to this conversation with more historical context.

Figure 3



Source: BLS Job Openings and Labor Turnover Survey JOLTS data

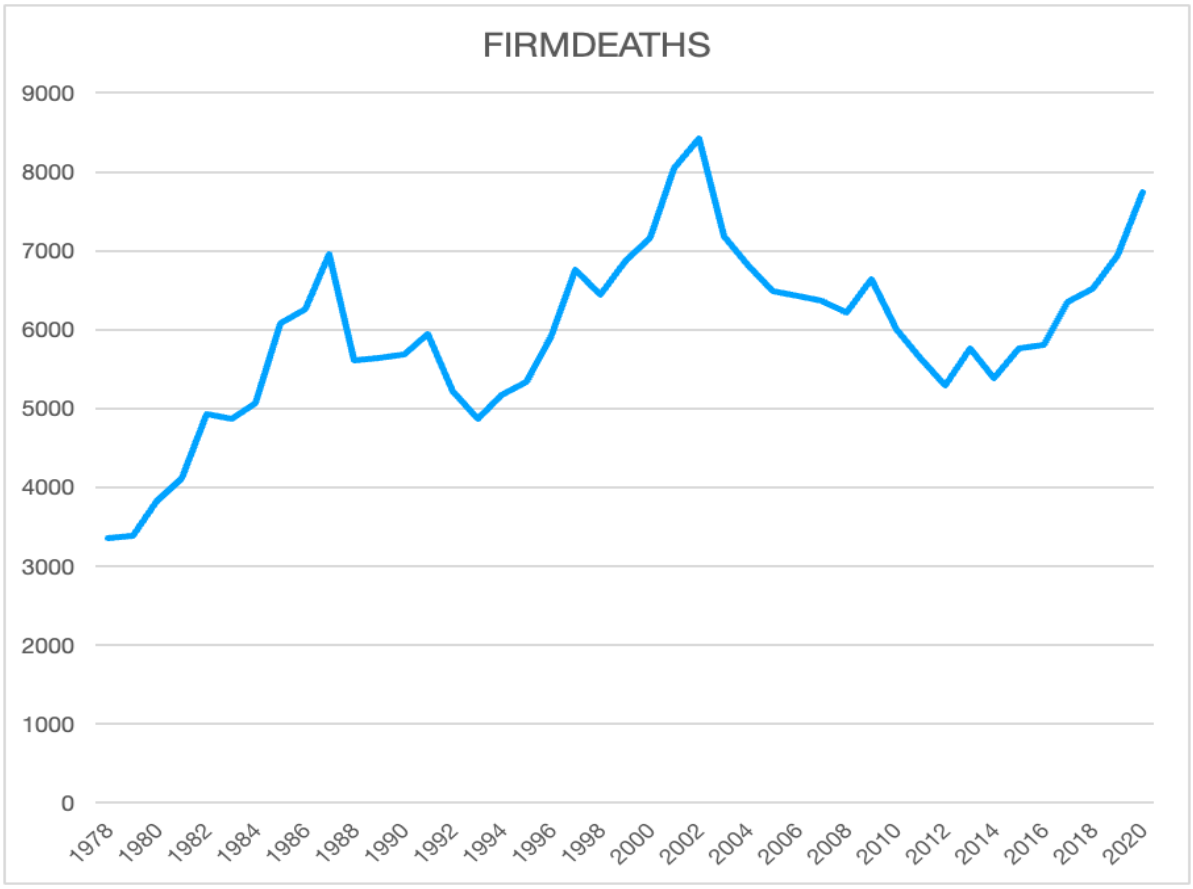
Note: Total separations include quits, layoffs and discharges, and other separations

Figure 3 shows the BLS's seasonally adjusted monthly rates of hires and separations from the published Job Openings and Labor Turnover Survey (JOLTS) data. The data is collected from a sample of approximately 21,000 US business establishments and covers all 50 States and the District of Columbia. It serves as a way to have data regarding the demand-side indicators of labor shortages at the national level.

Figure 3 also adds to the historical story of the information sector beginning in 2000. Although there had been significant peaks in job opening rates throughout time, post-2020 saw the largest spike since 2000. Further, as visible, separations and hires tracked closely alongside one another up until the pandemic, when the separations rate skyrocketed, and the hires rate dropped. Then, as the BEDs data previously showed, the industry overcorrected for this by opening the most jobs in 2021. As of January 2023, the industry appears to be evening out. However, it also shows that the separation rate is rising again, implying that the layoffs may not ease off anytime soon. This also tells us that the job churn during the pandemic was the highest in experience because the difference between job openings and hires against quits and layoffs grew greatly.

Another factor to consider that contributes to layoffs and lost jobs is firm deaths. This is important because employment is the outcome variable and therefore needs to be understood fully first. Therefore, as implied, when a firm closes, the employees are subsequently laid off. Firm deaths over time are tracked below in Figure 4.

Figure 4



Source: U.S. Census Bureau, BDS Explorer

Figure 4 uses data collected for Business Dynamics Statistics (BDS), a product of the US Census Bureau. The data is compiled from the Longitudinal Business Database (LBD), which is constructed by linking annual snapshot files from the Census Bureau's Business Register (BR). It is worthwhile noting that "firm deaths are events where all the establishments associated with a particular firm and the firm itself cease all operations. Note that firm legal entities that cease to exist because of merger and acquisition activity are not classified as firm exits in these data" (United States Census Bureau).

As shown in Figure 4, the number of firm closures peaks during macroeconomic downturns, such as the 2000 dot-com bubble and crash. As visible, the current economic slowdown is mirroring such effects, with a spike in firm closures. However, this data only goes up until 2020, and so it is challenging to conclude that such trends are identical just yet.

C. Industry-Wide Analytics

I collected data from the Current Employment Statistics - CES (National) from the BLS to understand the information sector's hiring and firing patterns from an industry-wide perspective. The employment data is sourced from the Current Employment Statistics Program, a federal-state cooperative program. The data is collected by surveying approximately 122,000 businesses and government agencies. Further, I used the US Census Economic Census, which is information provided by businesses and compiled by the Census Bureau.

I used these data sets to help understand which factors, between total wages, industry-wide revenue, interest rates (a representation of macroeconomic trends), and productivity, contribute to changes in employment, namely layoffs. Productivity is measured as industry-wide revenue divided by the total number of employees in the sector. Productivity is a metric often referred to as revenue per employee (RPE) in the technology industry's language, such as SaaS metrics.

I ran two time-series regressions to conduct this analysis of the information industry as a whole. They both consisted of the employment count as the outcome variable. The first was without any lags, and the second, lagged all the independent variables by one quarter. The results of these regressions are presented in the table below.

Table 1

VARIABLES	No Lag	Lagged One Quarter
Interest Rate	1,717 (3,352)	26,802* (14,886)
Revenue	7.813*** (0.000256)	4.298*** (0.00114)
Productivity	-20.84*** (0.743)	-10.49*** (3.414)
Constant	2.700e+06*** (24,409)	2.456e+06*** (108,173)
Observations	52	51
R-squared	0.987	0.745

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Sources: Federal Reserve Bank of St. Louis and U.S. Census Bureau

Note: revenue and productivity are measured in millions

In these regressions, interest rates are measured by the Market Yield on U.S. Treasury Securities at 10-Year Constant Maturity, Quoted on an Investment Basis. The Federal Reserve gathered this information from the Board of Governors of the Federal Reserve System (US). Interest rates were an independent variable considered because I want to see if they affected layoffs. The theory behind this was that if risk-free rates increase, all rates go up, and so the cost of borrowing and funding grows. For all companies, especially ones in the technology sector that are starting up and are dependent on funding and their projected growth, the need to borrow is imperative for success. Therefore, when this becomes more challenging, firms are less able to succeed and subsequently close. However, interest rates by themselves, once controlled for by the other dependent variables, do not correlate with layoffs. Even though it does affect revenue, it is not statistically significant for employment as a whole in either regression.

Further, on the left-hand side, Table 1 shows that without any lags, revenue and productivity are statistically significant and correlated to the change in employment in the technology industry. Revenue has a positive correlation, while productivity has a negative one. This means that an increase of $1 million in industry-wide revenue corresponds with a 7.8 employee increase. Further, a $1 million/per person increase in productivity leads to a decline in 20.8 employees. This trend has been followed quarterly starting in 2009.

On the right side, Table 1 shows variables lagged by a quarter. Similar trends appear as both revenue and productivity are statistically significant in the same manner. This tells us that last quarter's revenue is positively correlated with this quarter's hiring. Meanwhile, last quarter's productivity is negatively correlated with this quarter's employment.

The correlation between revenue and employment is more intuitive; companies can afford more labor, and their firm's growth and so hire more as revenue increases. However, the negative relationship between productivity and employment is less intuitive, as when workers become more productive, firms hire less. One potential explanation for this is that firms are able to get more output per worker, and so can get away with fewer employees. Historically, this trend has influenced hiring patterns in the technology sector. So it is instructive to understand when attempting to explain the hiring and firing patterns caused by the COVID-19 pandemic from 2020 through 2023.

The fact that wages and interest rates are not statistically significant is also worth noting. This means that changes in wages and the interest rate are not strong predictors for employment patterns across the information sector.

These patterns in the regressions are represented in the following graphs (Figure 5 through Figure 8) to aid the visualization of employment in the technology sector.

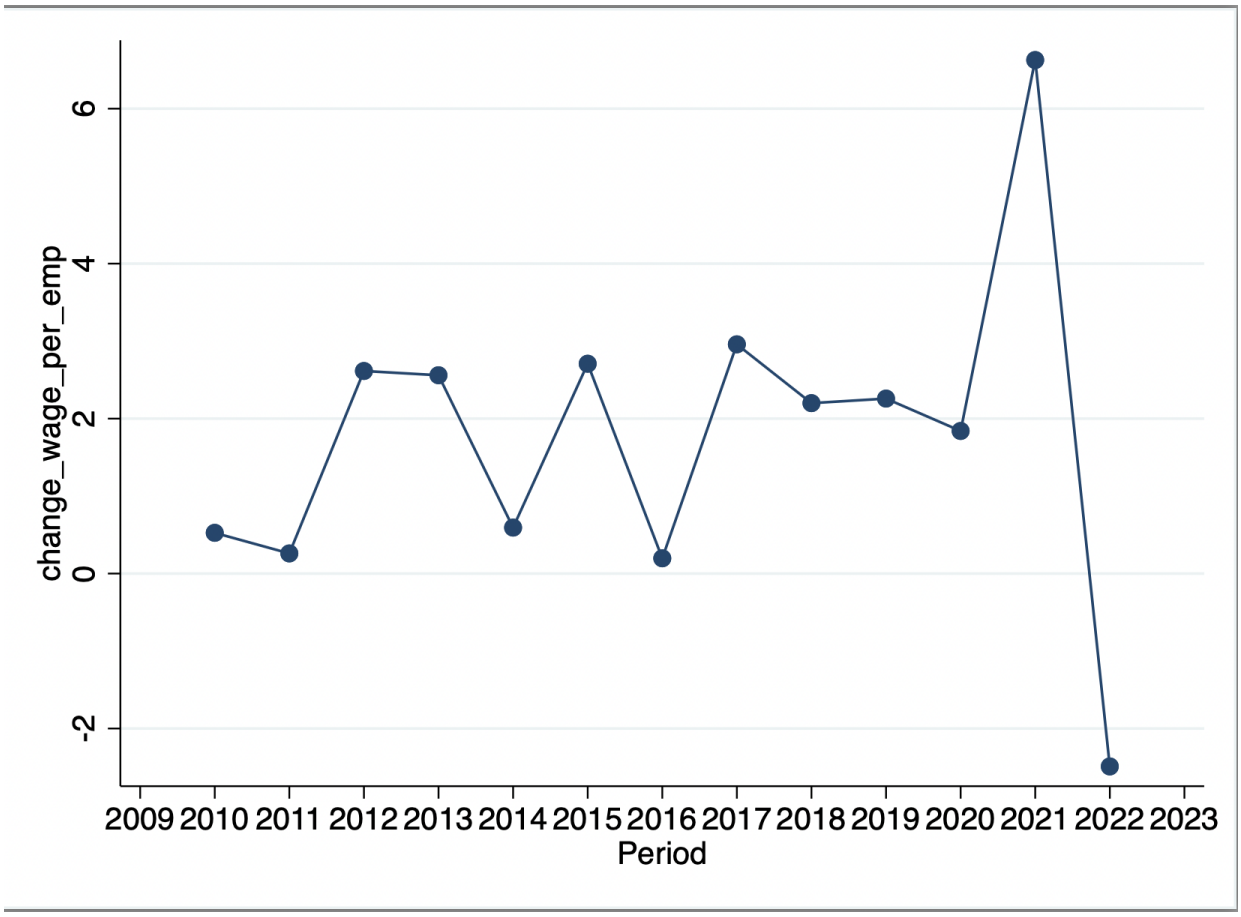
Figure 5

Source: Current Employment Statistics - CES (National) from the BLS

Note: Figure 5 is seasonally adjusted

Firstly, it is worth showing the total employee count across time. As visible in Figure 5, the annual employment count followed a similar pattern from 2011 to 2019, as it experienced some ebbs and flows but always trended upwards consistently. However, once the pandemic took effect, there was an aggressive drop in employment in 2020 before quickly spiking again to unprecedented levels in the information sector. This graph helps visualize the pattern addressed in the introduction regarding how technology companies overcorrected for the COVID-19 pandemic by overhiring. As we now know, the industry then laid off many of these workers, which likely will be visible in the annual 2023 numbers.

Figure 6



Source: Current Employment Statistics - CES (National) from the BLS

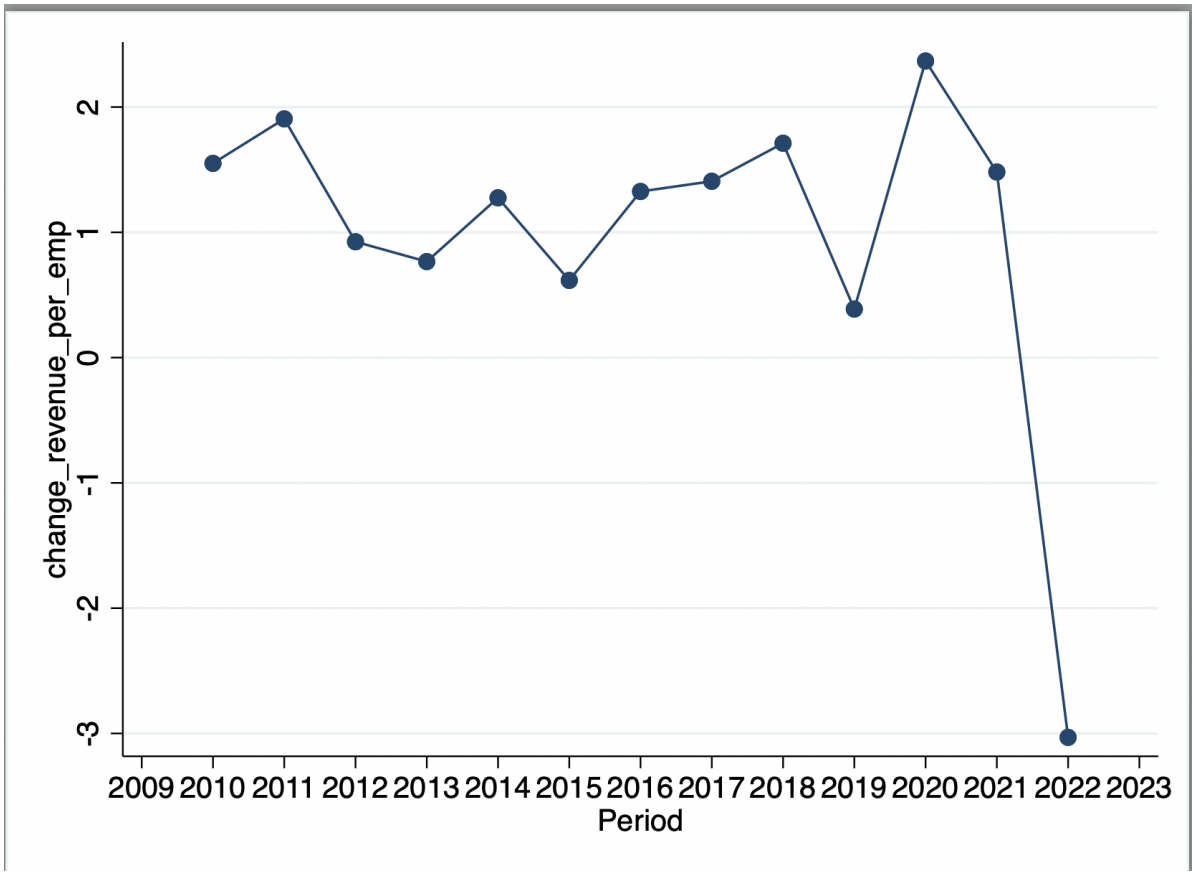
Figure 6 shows the percentage change in wages per employee annually. As visible, before the pandemic, wage growth per employee fluctuated around the same range of 0 to 3% change but never saw a negative percentage change or a decline in wages per employee. However, after the pandemic, wages increased at an unprecedented level of growth of over 6%. Once the industry began to feel the effects of their overhiring and started to initiate layoffs, wages also corrected by dropping -2%, showing the first lowering of wages since 2009.

One theory that can help this behavior of the technology industry is the Goodwin theory. This theory says that wages increase because of previous employment trends. When there is an

increase in employment, such as in 2021 and 2022, employees have more bargaining power for higher wages, increasing the wage share. However, this subsequently decreases the profit share, so firms are now incentivized to cut labor, which we see occurring in 2022 and 2023.

Although wages were not statistically significant in the time series regression shown above, this behavior can help explain the trends visible in this graph.

Figure 7



Source: Current Employment Statistics - CES (National) from the BLS and the U.S. Census Economic Census.

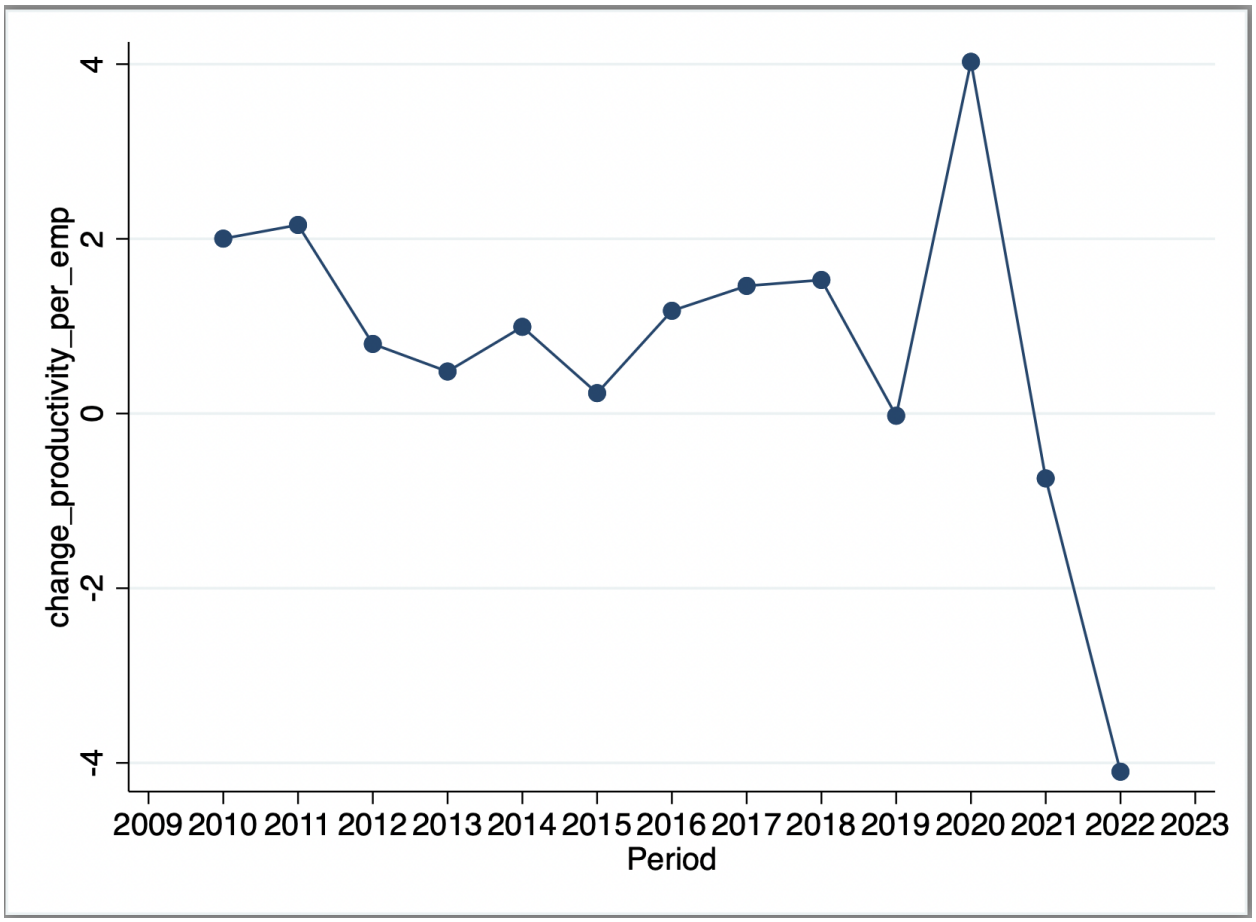
In addition to the CES data, this graph also uses data from the Economic Census, the official five-year measure of American business and the economy. Data provided by businesses fuel the most comprehensive economic statistics available, representing all US industries and geographies (United States Census Bureau).

Figure 7 represents the percent change in revenue per employee annually. This can also be seen as the productivity percent change in the industry. As this graph shows, the change in revenue per employee also remained around the same percentages of 0.5 to 2% pre-pandemic. Then, during the pandemic, revenue per employee increased for the first time since 2009 to be above 2% in 2020. This was because many technology companies' products grew in demand as the pandemic moved our world to an entirely digital space. Therefore, products like Microsoft Teams and Amazon became even more essential. We can infer that a demand increase is equivalent to a revenue increase. However, it is possible that the industry overestimated its demand. This is because once the industry hired into that higher demand curve, revenue per employee began to drop. So after the pandemic, revenue per employee saw its most significant decline down to -3% and shrunk for the first time since 2009. Ideally, companies and the entire industry want to maximize their revenue per employee ratio as this ratio leads to larger productivity, which often indicates higher profits and success. Here, this metric shows that productivity for the whole industry declined by around 3% due to overhiring.

This metric also shows us that the industry overhired past what the revenue called for. Previously, revenue per employee remained around the same ratio because every hire was balanced by a relatively equal revenue increase. However, after the pandemic, around 2021, when firms hired more employees than the revenue allotted for, revenue per employee declined dramatically, which is visible above. Now, firms are trying to correct for that by laying

employees off. Nonetheless, this correction has yet to be visible as the layoffs only came about at the end of 2022 and through 2023, which still needs to be accounted for in these numbers.

Figure 8



Source: Current Employment Statistics - CES (National) from the BLS

Figure 8 follows the same suit as Figure 7; revenue per employee (average productivity) is often a strong indicator of marginal productivity per employee. The key difference between these two metrics is that average productivity explains the output of each worker, whereas marginal productivity graphs the output from adding an additional worker. Therefore, during the

pandemic, the change in productivity per employee, or marginal productivity, increased to 4%, higher than ever before. However, once the industry overhired, the productivity of each worker was not sustainable, and therefore, the change dropped around 8% down to -4% in 2022, meaning that again, for the first time, productivity was actually declining. Economic theory helps explain this because when capital is fixed, there is an equilibrium point where the number of employees can maximize the capital at their disposal to maximize quantity. However, now that there were more employees and the same amount of capital, workers could no longer maximize their productivity, and so productivity subsequently declined.

D. Company-Specific Descriptive Background

As alluded to in the introduction, this paper will also use company-specific data to understand layoffs on a more micro scale. The companies chosen are the 11 companies with the largest raw number of employees laid off. In order of layoff magnitude, they include Amazon, Alphabet, Meta, Microsoft, Salesforce, Cisco, IBM, Uber, Groupon, Zillow, and PayPal. These companies will serve as a look into the industry as a whole, as they represent a diverse range of industries within the technology sector.

The press releases related to these rounds of layoffs all cite similar problems for these decisions, namely, the demand for their products during the pandemic caused their need for increased labor. These demands have fallen during the 2022/2023 economic slowdown, so the headcount has had to mirror that drop. As previously mentioned, revenue and demand are equated here. For example, Marc Benioff, the co-founder and CEO of Salesforce, said, “As our revenue accelerated through the pandemic, we hired too many people leading into this economic downturn we’re now facing, and I take responsibility for that” (Balu, 2023).

A few factors that help understand some of these companies more are their individual employment levels, revenue, and productivity, both on an average and marginal scale. I also graphed their annual net income to show whether these firms remained profitable in the face of these layoffs. Those graphs are also below. The numbers go up until 2022 for everything except for employment, as I want to highlight that layoffs are still occurring in 2023 and include the most up-to-date employment counts.

The trends outlined below are sourced from Macrotrends's employee count and revenue per company. Macrotrends source their information from Zacks Investment Research. Then, productivity was found by dividing revenue by employee count, the same metric used above for the industry-wide measures.

Amazon:

Figure 9

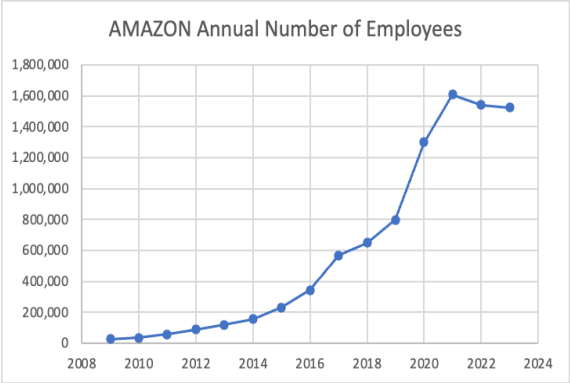
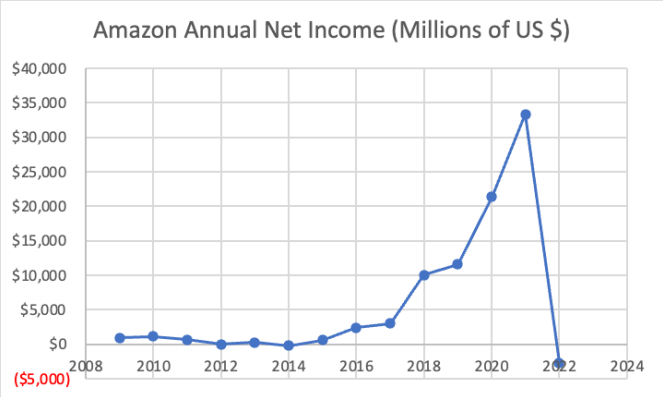


Figure 10

Figure 11



Figures 10 and 11 show how the demand for Amazon increased during the pandemic, with a larger increase during 2020 and 2021 than it previously had ever experienced since 2009. However, after the pandemic, the demand slowed, as seen in the slowed growth of revenue and the negative net income for 2022.

Figure 12

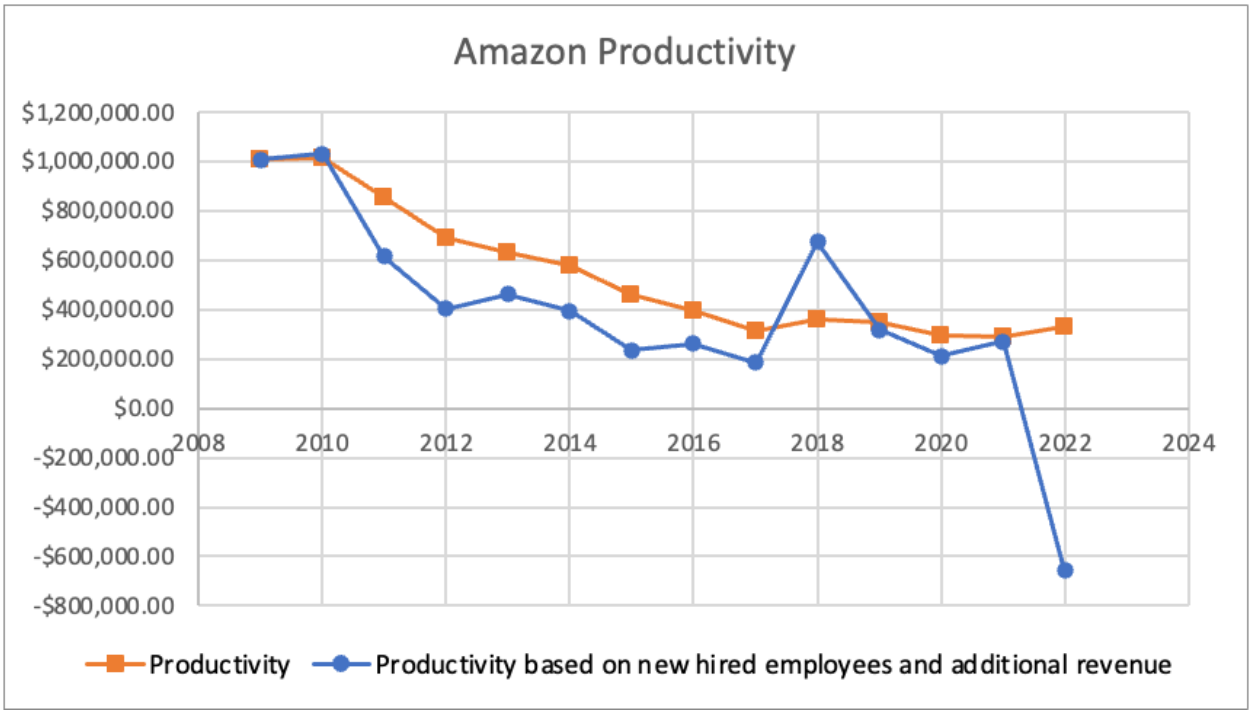


Figure 12 includes both productivity for that year for Amazon as well as the productivity of the additional hires and additional revenue for that year. These are both relevant metrics as productivity helps explain the overall success of the firm, while additional productivity helps explain whether new hires were worthwhile for the firm or not. This explanation holds true for the productivity graphs for each of the firms below.

Amazon is the strongest example of diminishing marginal return on employment out of the companies examined. Figure 12 shows how as time increases and more employees are hired, the productivity of each individual worker declines more often than not, shown by the blue line. This is exacerbated at Amazon as opposed to its counterparts graphed below because its employment also includes warehouses and delivery workers, unlike other technology companies whose workforce is primarily white-collar employees.

To understand how each company compares to one another, it is best to put the labor changes in percentage terms. I will compare the employment increases from 2018 to when their employment peaked and the percentage change post-peak. Amazon experienced a 246% increase in employment from 2018 (pre-pandemic employment) to 2021 (their peak). Then, from 2021 to 2023, Amazon reduced its headcount by around 5%.

Alphabet:

Figure 13

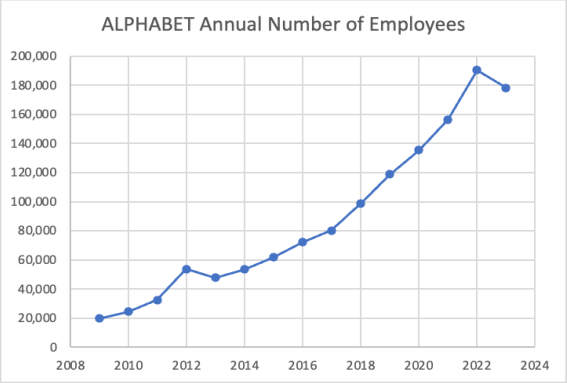


Figure 14

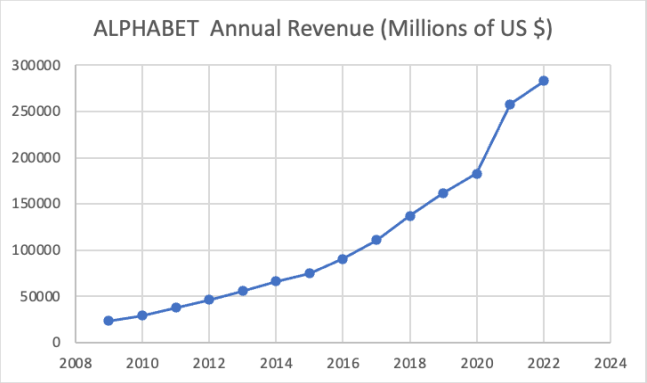
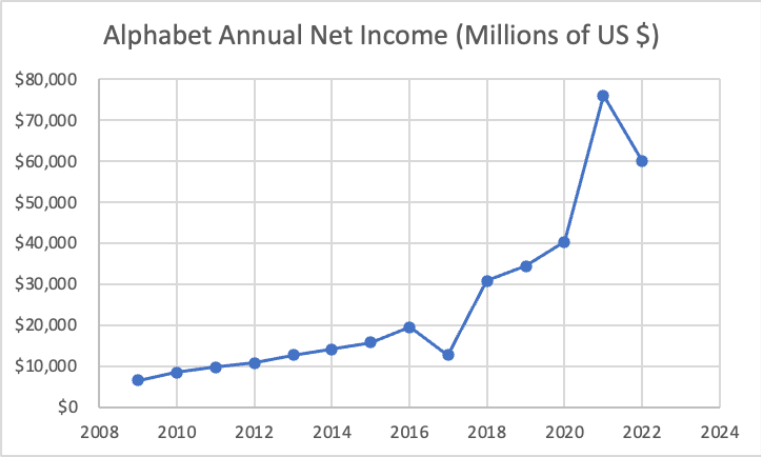


Figure 15



Figures 13, 14, and 15 also show how the demand for Alphabet increased during the pandemic, with a more considerable increase during 2020 and 2021 than it previously had experienced. Before the pandemic, Alphabet had seen a steady increase in employee count, revenue, and net income (aside from the dip in 2017). After the pandemic in 2022, annual revenue slowed, and net income dropped for the first time since 2017.

Figure 16

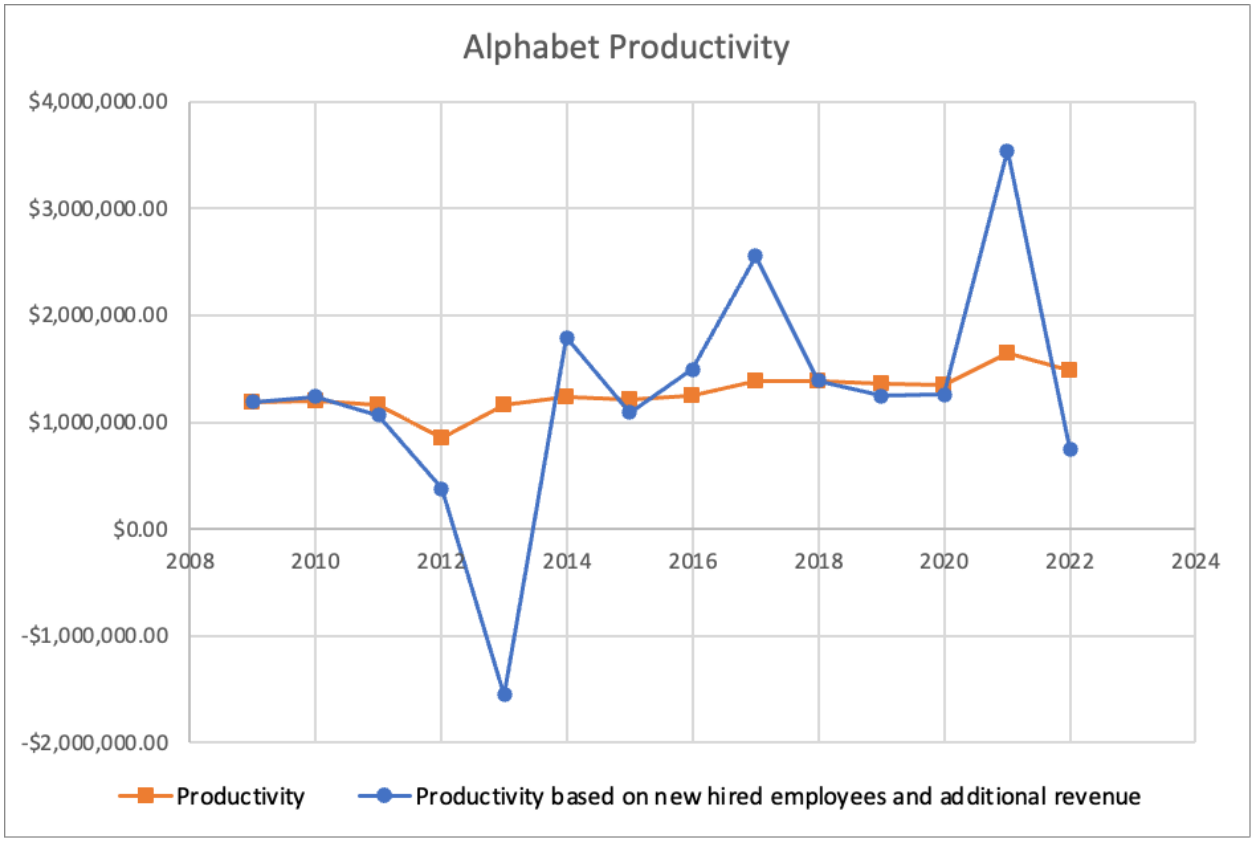


Figure 16 shows how Alphabet has done reasonably well compared to its counterparts, as its productivity margins have remained mostly consistent. This can be explained partly because Alphabet has a large monopoly on its market, so a constant stream of revenue is more guaranteed for them compared to similar technology companies. However, its profitability dropped prior to

its mass layoffs because it overhired when revenue did not call for it, showing that even Alphabet was affected.

To help compare Alphabet to its counterparts, we can see that it experienced a 53% increase in employment from 2018 to 2022 (the peak) and slowed headcount by 6.3% between 2022 and 2023. Therefore, even though Alphabet's marginal productivity declined, it was able to stay positive in the face of significant layoffs (while Amazon's became negative, for example).

Meta:

Figure 17

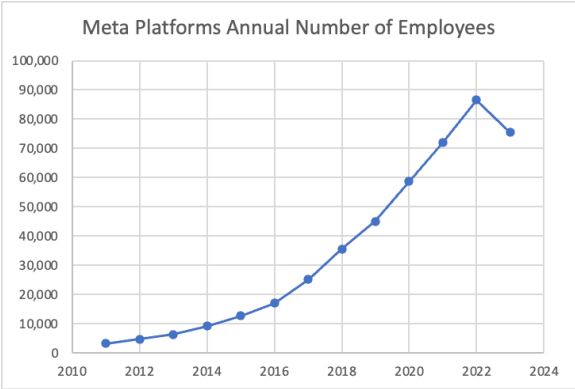


Figure 18

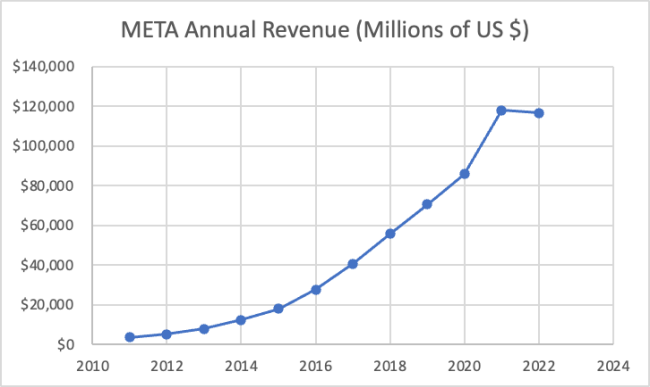
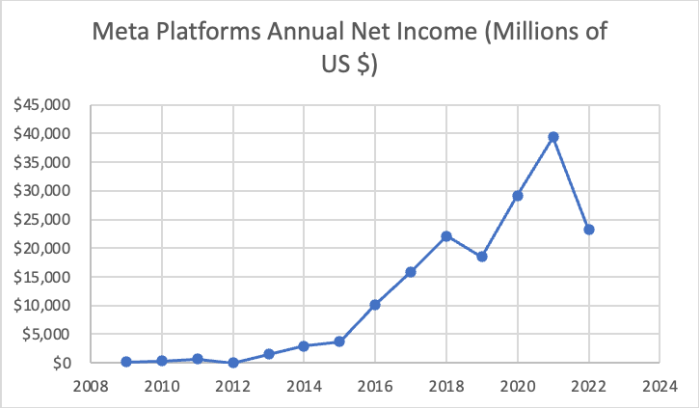


Figure 19



Before the pandemic, Meta also constantly increased headcount and revenue. Even though net income was less stable, it followed a similar trend of increasing until the pandemic. Additionally, as also mentioned for the previous companies, Meta saw an increase in demand during the pandemic years, as visible in Figure 18 in the spike in revenue between 2020 and 2021. However, after the pandemic, in 2022, demand also slowed, and net income dropped the most since 2009.

Figure 20

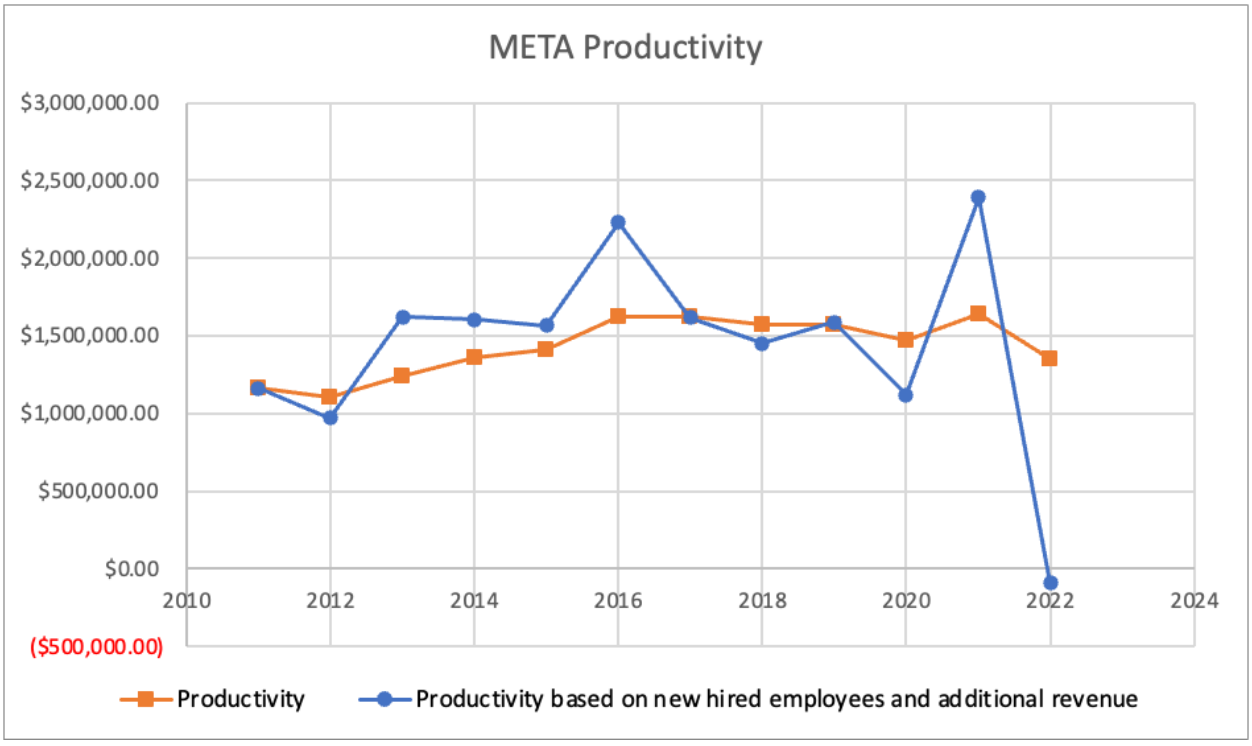


Figure 20 shows that Meta's marginal productivity is not just slowing but is now reaching negative productivity as of 2022. One reason that could help explain this is that its core business is less stable and that its business is less robust in the current environment of raising interest rates. As a result, its employees cannot be productive, no matter how talented they are

individually. Therefore, this metric is dropping faster than their counterparts, such as Alphabet (which is more resilient in this economy, and therefore employee output can be more stable).

To add percentages into the conversation, between 2018 and 2022, Meta grew their headcount by 151%. Between 2022 and 2023, their headcount has shrunk by almost 15%, the largest decline in headcount compared to their pool.

Microsoft:

Figure 21

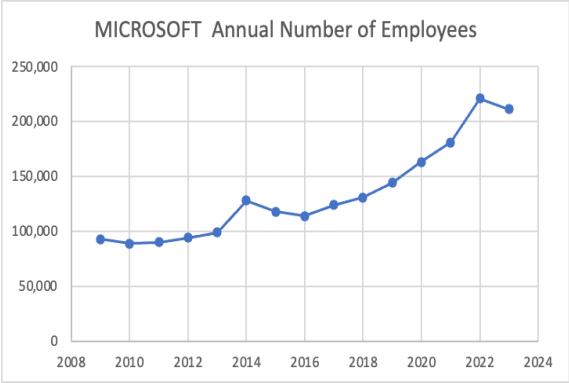


Figure 22

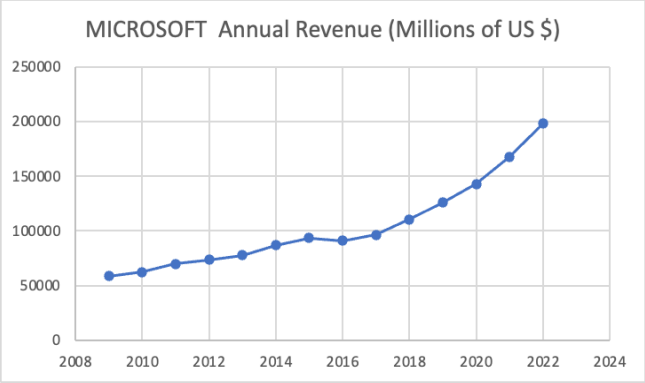
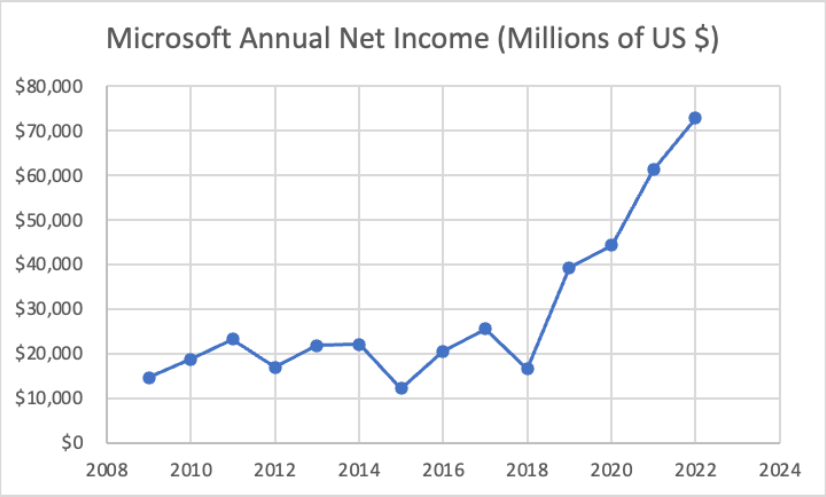
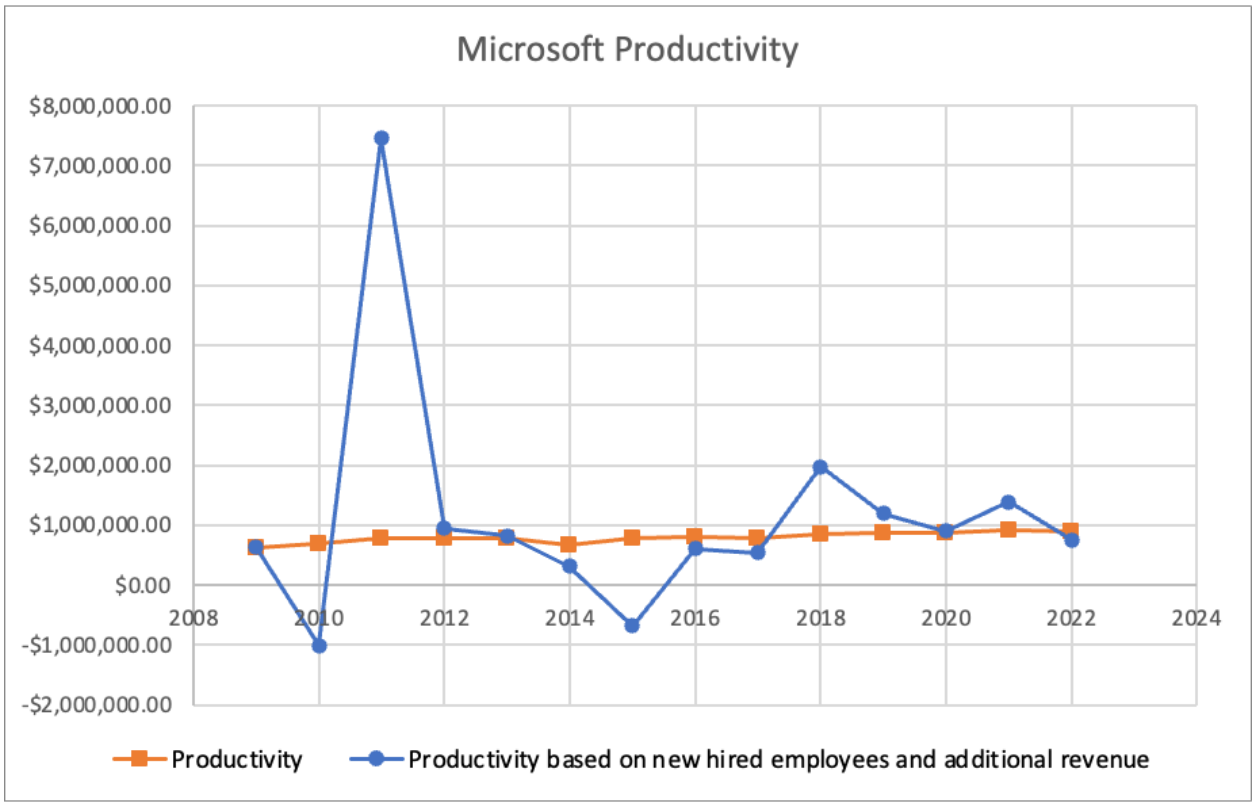


Figure 23



Unlike the previous companies, Microsoft did not see a drop in net income after the spike in demand during the pandemic. Instead, it experienced a more steady revenue increase from 2016 through 2022. This makes sense for why Microsoft also had a more consistent headcount growth.

Figure 24



As visible in Figure 23, Microsoft only grew its employee count by 68% between 2018 and its peak in 2022. Further, this helps explain why their productivity is much more stable than the other companies, as shown in Figure 24. Between 2022 and 2023, Microsoft has shrunk its employee count by around 8.5%. Therefore, Microsoft's strategy was more stable and consistent, allowing them not to lose as much productivity during their post-pandemic era.

Salesforce:

Figure 25

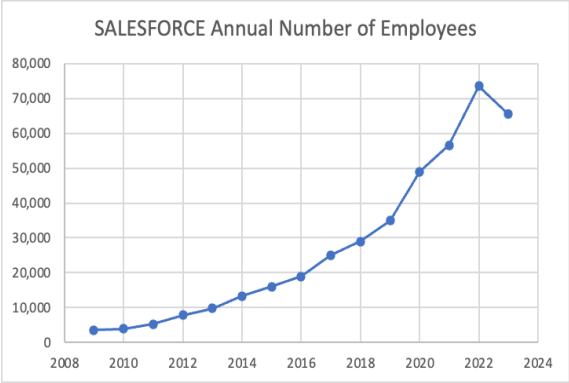


Figure 26

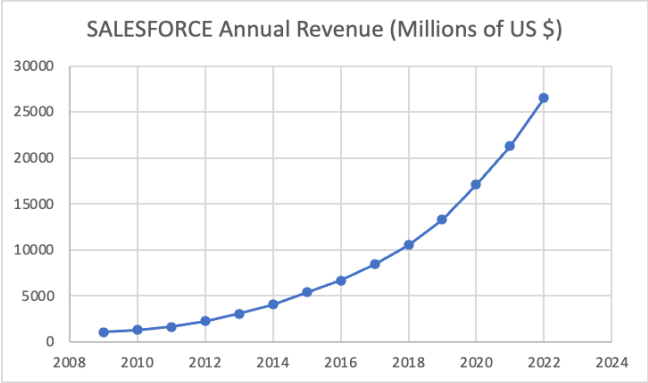
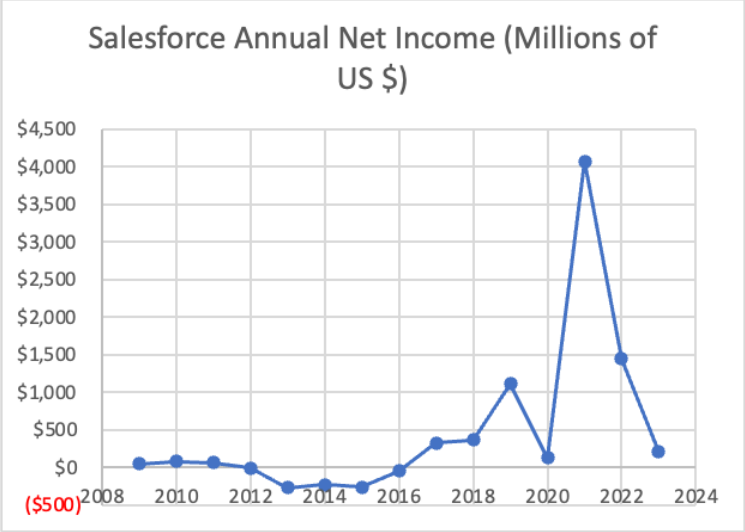
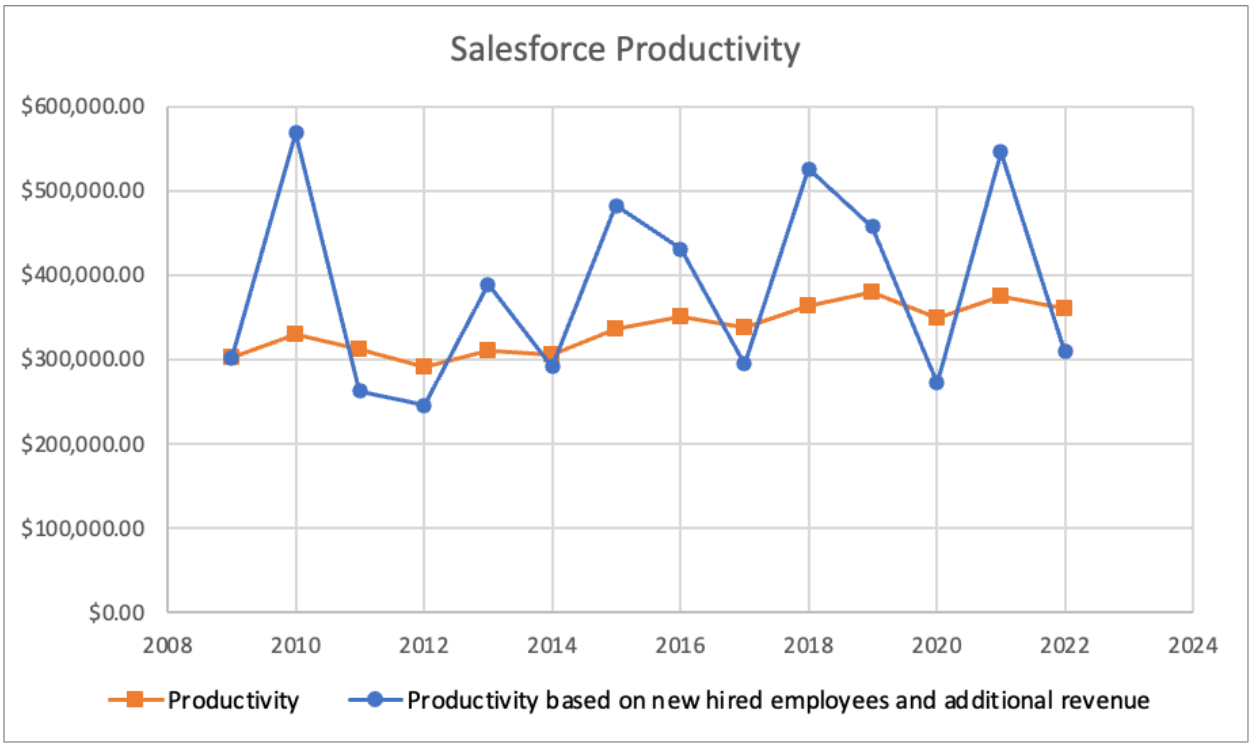


Figure 27



Similar to Microsoft, Salesforce also experienced a more steady increase in revenue over time. However, they did have more demand during COVID-19, with a more significant jump in revenue between 2021 and 2022. However, their net income was quite volatile, dropping after the highest peak in 2021.

Figure 28



As visible in Figure 28, Salesforce is the only company that is growing and increasing its revenue before hiring to keep up with its growth systematically. As their revenue increases, they hire more employees and balance out their marginal productivity until revenue gets high enough again to increase their labor force. Even though Salesforce experienced layoffs, its productivity never drastically dropped below its averages, showing a more stable business model compared to some of the other companies mentioned.

Salesforce grew its headcount more than many other companies by increasing it by around 153% between 2018 and 2022. However, this hiring was less detrimental because their revenue also grew. As visible in Figure 28, Salesforce's revenue growth was stable and incremental, helping their consistent productivity. Salesforce has decreased its headcount by around 11.5% between 2022 and 2023.

These five companies provide background information about the trends that big tech has experienced over the last decade and a half. They are by no means a complete representation of the information industry; however, they help provide more context and background information to gauge patterns and trends. More specifically, they help explain and demonstrate that the pandemic and post-pandemic era offered an unprecedented dip in revenue and productivity on a company-specific scale. This tells us that technology companies respond to overhiring in a few different ways, so we cannot generalize the technology industry's response to one concept. Instead, their responses depend on the magnitude of their overhiring and whether their business model is sustainable in the face of an economic slowdown. Additionally, the magnitude of layoffs is not the main predictor of the success of that company; instead, the company's ability to maintain net income and revenue, and therefore, productivity, is a stronger indicator of their resiliency.

One note to add is that when searching for quarterly employment levels of these companies, the majority did not include their headcount on their 10Qs and 10Ks, furthering the theory that headcount has not been a priority for technology companies. Instead, markets and individual companies have been narrowly focused on proving their projected growth and profitability without considering how employee headcount impacts those factors.

E. Company-Specific Analytics

With the same metrics explained and used above, I ran two fixed effects panel regressions (one not lagged and one lagged by a year) to see how the independent variables, revenue and productivity, affect the outcome variable, namely employment levels. The findings of these regressions are in Table 2 below.

Table 2

VARIABLES	Not Lagged	Lagged by 1 Year
Annual Revenue in Millions	2.617*** (0.550)	2.678*** (0.421)
Productivity	-208,981* (100,481)	-391,015** (131,047)
Constant	109,401 (82,395)	234,444** (93,526)
Observations	136	129
Number of companies	11	11
R-squared	0.862	0.862

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: revenue and productivity are measured in millions

Table 2 shows the results of the fixed effects panel regressions for total employment with robust heteroskedasticity errors. Over time across the same 11 companies, the leading contributor to layoffs has been the demand for that company's product, otherwise known as the change in revenue.

As shown in the not lagged column, an increase of $1 million in the company's revenue corresponds with a 2.6 increase in employees on average since 2009. This is to be expected, as it is lower than the industry-wide regression. This is because these companies are ones with exceptionally high productivity for the industry, and therefore, they require fewer employees to generate output.

Because this regression captures most pre-pandemic trends, it tells us how previous trends have influenced employment overtime on a company-specific level. As visible in the

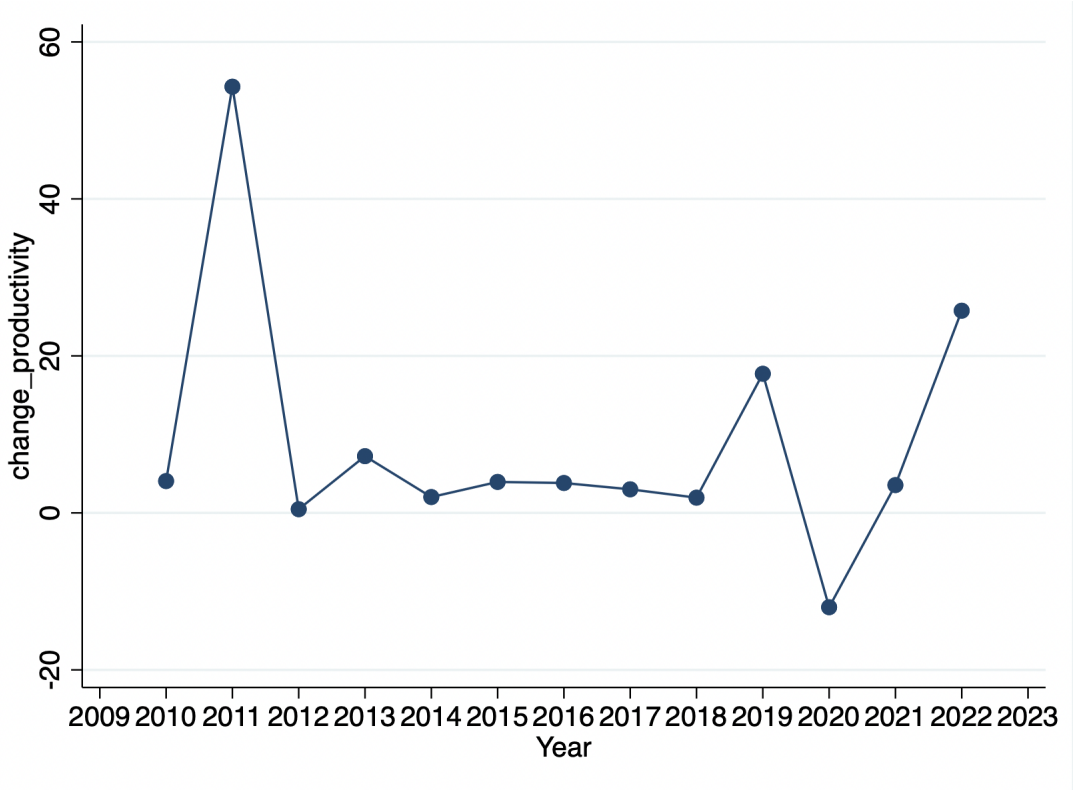
regression, productivity has not been as large of a contributor to layoffs, as historically, firms have been responsible with their hiring and only hired when their revenue and net income called for it. However, many firms strayed from this trend during the pandemic and hired more than their revenue permitted, reducing productivity and net income. Therefore, layoffs are a result of overhiring. Even though demand/revenue did increase during the pandemic, it did not increase to the extent of steady productivity. Therefore, productivity historically is not a predictor of layoffs. However, after the pandemic, it became more relevant and so may be a more significant contributor today.

It also is important to look at how the previous year's patterns affected the current year's hiring. The panel regressions on the right side of Table 2 demonstrate that concept. This panel regression follows a similar trend as the non-lagged one. However, in addition to revenue being statistically significant, productivity also is a significant factor for employment levels the following year. The same reasons already mentioned apply to why revenue is also statistically significant here. However, it is worth understanding why productivity is statistically significant and negative here. The negative coefficient means that, since 2009, after these 11 firms have increased their employee productivity, they have been able to maximize their output and therefore do not need as many employees in the following year. Throughout history, we can see that a productivity increase contributed to slowing hiring in the past.

However, the current layoff phenomenon is not due to an increase in productivity, as we know that productivity did not increase for any of these 11 firms, as shown in the productivity graphs above. Therefore, we can infer that the overhiring was more a product of the higher demand expectations during the pandemic without the revenue to back it and allow productivity to stay steady and positive.

The graphs below show the relationships drawn out in the regressions above. The y-axes are in percentages for comparability.

Figure 29



Because productivity is the result of revenue divided by employees, the below graphs in Figures 30 and 31 also help understand the trends visible in this graph. As shown, 2020 was the first time the change in productivity declined (seen as a negative percentage). This occurred because firms began to hire more employees to keep up with the revenue growth they expected to see during the pandemic. As seen below, productivity decreased because employees increased while revenue did not increase at the same rate, throwing off the productivity ratio. In 2021, productivity almost became in line with the pre-pandemic range, but it did not stay there long, as in 2022, productivity shot up to above a 20% increase. This was because there was still some

revenue growth in 2022, even though it was at a smaller rate (seen in Figure 30), which caused productivity to increase. Additionally, the employee count started to decline with layoffs in 2022 (seen in Figure 31), and that also increased productivity. With both of these happening in conjunction, it caused a significant productivity increase, visible in Figure 29.

Figure 30

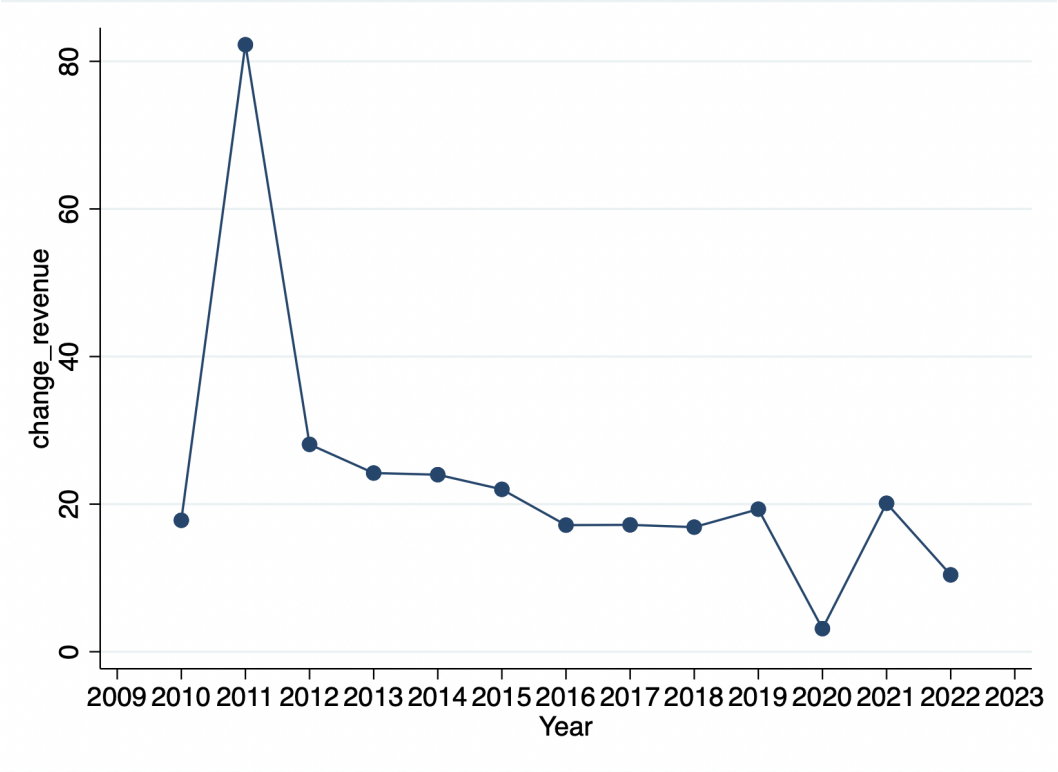
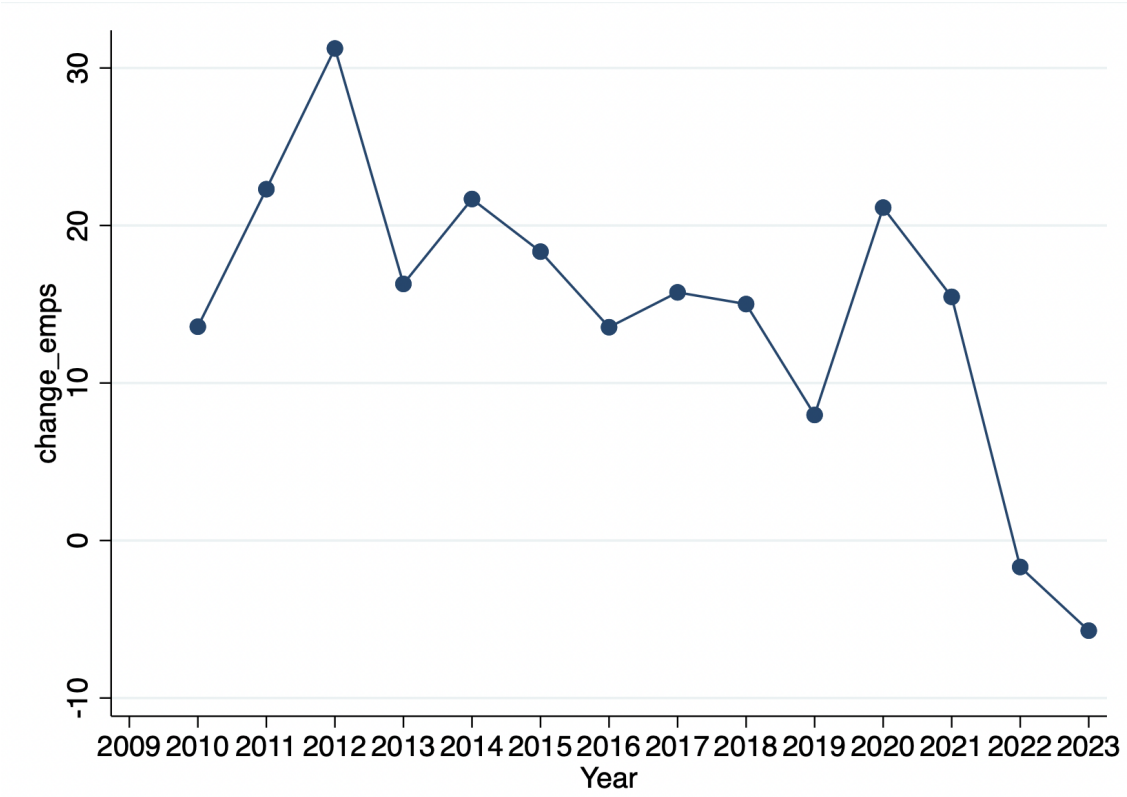


Figure 30 maps the percent change in revenue starting in 2009. As visible, revenue remained relatively stable between 2012 and 2019 as year-over-year revenue grew by around 20%. Then, in 2020 when the pandemic hit, revenue stalled for the first time by almost hitting a 0% change. In 2021, revenue increased to around 20% growth at pre-pandemic levels. However, because there was such growth between 2020 and 2021, firms believed their demand was spiking and expected it to continue to grow even more than the average. Therefore, they hired into that

expected growth, as seen in Figure 31. In 2022, revenue increased at a slower rate of around 10%, largely due to the increase in interest rates, which was different from what firms expected their revenue to be. Therefore, they had to lay off employees as their revenue did not match the expected ratio they hired for.

Figure 31



Lastly, as already mentioned, Figure 31 shows the percent change in employment in the information industry since 2009. The graph shows that the year-over-year hiring pattern fluctuated around a 15% to 20% increase between 2013 and 2018. This helps explain why productivity was relatively stable during those years, as revenue during those years grew around the same rate and therefore permitted for the headcount growth. However, in 2020, headcount grew above a 20% rate, while revenue slowed almost down to 0% growth, causing productivity

to decline. As previously explained, firms hired above 20% because they expected revenue to grow during the pandemic. Then, firms began to correct in 2022, as visible on the graph, where 2022 is below 0% growth, meaning that there was no employee growth and even layoffs. Therefore, in 2022 productivity increased because there was no employee growth, yet revenue was still increasing.

IV. Conclusion

For approximately the last two decades, hiring patterns in the technology industry have been relatively consistent. Firms, and therefore, the industry as a whole, were very strategic regarding their hiring strategy, as they would only hire when the demand, also known as the revenue, permitted it. When a company grew enough, hiring and expanding their business was deemed permissible, so hiring would increase. Because the technology industry is constantly growing, revenue, employment, and, subsequently, productivity all grew at a very steady state. Then, when the pandemic hit, firms saw that their revenue increased slightly more than average, and they got overzealous and expected that the technology craze would continue to expand throughout the pandemic. Therefore, they hired preemptively based on what they expected 2022 to look like, but that was not the case, so they had to let go of more workers. Therefore, they broke hiring patterns and hired into that expected demand/revenue without the same financials to back those actions as previously seen in the industry.

As a result of these findings, I do not believe we need to be all that worried that firms are correcting for their overhiring through these layoffs like the media has made it out to be. However, I believe it is more worrisome that firms overestimated their revenue and projected growth too much, causing this phenomenon. If this becomes a pattern, the technology industry

will continue to see aggressive layoffs. Nonetheless, it is worth mentioning that solely basing predictions on history, this phenomenon would have been challenging to foresee. Therefore, although with this new information, we are able to understand the industry further, it is still hard to predict the future of tech layoffs. In order to do so, we first must see where interest rates, and subsequently revenue, are headed before assuming anything further.

Another point to note that came out of this research is that the magnitude of layoffs is not the main predictor of the company's success. Instead, net income is a more accurate metric, and we cannot generalize that firms are less successful because of their overhiring.

Although the data used in this paper does not confirm or reject this notion, another reason firms may have been incentivized to hire more during the pandemic was because of strategic interaction motives. This meant that firms were hiring to obtain talent and ensure other firms could not utilize them. Even if these employees were not being utilized to their full potential and therefore were not as productive, they could have been hired to hoard talent and keep them away from the competition. This concept would be interesting to continue investigating through research such as interviews.

With that being said, I also wanted to create a section dedicated to potential ideas for future research that can come out of this paper.

The first is, how many of these layoffs were destined to occur due to creative destruction, especially with the influx of artificial intelligence (AI) into the technology sector, and how much was a product of overhiring and the overcorrection for the pandemic? We know that human resources (HR) was a sector that was especially hit by these layoffs. This is partly because the industry is becoming increasingly automated with AI resume and cover letter scans to streamline

the interviewing process. Does that mean that even though companies overhired, these layoffs were bound to happen sooner rather than later?

Another topic to explore is a case study of Apple, the technology company that held off mass layoffs the longest (up until April 2023). We know that Apple did not overhire like the majority of other technology companies, and so was able to remain profitable and consistent as a result. However, is there more to be understood there? Why did they eventually face layoffs? Was it just the nature of the economy, part of creative destruction, or another reason I have yet to explore?

Next, it would be worth investigating the role of capital in each firm's productivity changes. Usually, capital is considered a fixed expenditure; however, during the waves of layoffs, firms also chose to close office spaces and cut down on costs that way. Therefore, it would be worth understanding capital's role as a variable expenditure in the profitability and productivity of the industry as a whole and for individual firms.

Lastly, exploring the labor market for these technology companies in Europe would be interesting. Since Europe has much stricter labor laws, they have been unable to lay off people, especially to the same degree. Therefore, it would be worthwhile to investigate how keeping these employees around affects the industry, especially in relation to how the United States looks after all these layoffs.

V. References

U.S. Bureau of Economic Analysis, “Personal Consumption Expenditures: Chain-type Price Index [PCECTPI]”, FRED, Federal Reserve Bank of St. Louis, https://fred.stlouisfed.org/series/PCECTPI.

Bureau of Labor Statistics, U.S. Department of Labor, “Current Employment Statistics - CES (National)”, https://www.bls.gov/ces/.

United States Census Bureau, “Business Dynamics Statistics (BDS) Explorer,” https://bds.explorer.ces.census.gov/?year=2020&xaxis-id=sector&xaxis-selected=31-33,44-45,54,72&group-id=fage&group-selected=010,065,070,075,150&group-group=2&measure-id=job_creation&chart-type=bar.

U.S. Tech Sector Analysis, Simply Wall St, https://simplywall.st/markets/us/tech.

United States Census Bureau, Business and Industry Time Series / Trend Charts, https://www.census.gov/econ/currentdata/?programCode=QFR&startYear=2000&endYear=2023&categories[]=INF&dataType=101&geoLevel=US&adjusted=0&notAdjusted=1&errorData=0.

Lee, Roger, “Tech Layoff Tracker and Startup Layoff Lists,” Layoffs.fyi, https://layoffs.fyi/?utm_content=null&utm_source=Sailthru&utm_medium=email&utm_campaign=Tuesday+Email&utm_term=4ABCD.

Bureau of Labor Statistics, U.S. Department of Labor, “Job Openings and Labor Turnover Survey (JOLTS)”, https://www.bls.gov/jlt/data.htm.

CSIMarket, “Technology Sector Profitability by Quarter, Gross, Operating and Net Margin from 1 Q 2023, CSIMarket, Inc., https://csimarket.com/Industry/industry_Profitability_Ratios.php?s=1000.

Ranganathan, C., and Kedar Samant, “Information Technology Personnel Layoffs in US Organizations: An Exploratory Investigation,” Information & Management, vol. 43, no. 2, Mar. 2006, pp. 239–250., https://doi.org/10.1016/j.im.2005.06.005.

Haltiwanger, John, et al, “Declining Business Dynamism in the U.S. High-Technology Sector,” SSRN Electronic Journal, 17 Feb. 2014, https://doi.org/10.2139/ssrn.2397310.

Valletta, Rob, and Kuang, Katherine, “Is Structural Unemployment on the Rise?,” FRBSF Economic Letter, 8 Nov. 2010, https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=3c24d50ff4f7a8db618e1950c3314a1d1eb203c6.

Wang, Xuan, et al, “The IT Labor Market amid the Pandemic: The Case of the United States,” IEEE Engineering Management Review, vol. 49, no. 4, 2021, pp. 41–53., https://doi.org/10.1109/emr.2021.3125615.

Ranganathan, C., Outlay, Christina, and Krishnan, Poornima, "Do Layoffs Payoff? An Empirical Investigation of Financial Impacts of IT Worker Downsizing", Dec. 2007, ICIS 2007 Proceedings. 27, http://aisel.aisnet.org/icis2007/27.

Charness, Gary, and David I. Levine, “When Are Layoffs Acceptable? Evidence from a Quasi-Experiment,” SSRN Electronic Journal, 1999, https://doi.org/10.2139/ssrn.163248.

Chebolu, Sekhar, “Analysis of Reasons for Layoffs by Technology Startups during Covid-19 Pandemic,” Shanlax International Journal of Management, vol. 8, no. S1, 2021, pp. 58–61, https://doi.org/10.34293/management.v8iS1-Feb2021.3758.

Jeon, Doh-Shin, and Joel Shapiro, “Downsizing and Job Insecurity,” Journal of the European Economic Association, vol. 5, no. 5, 1 Sept. 2007, pp. 1043–1063., https://doi.org/10.1162/jeea.2007.5.5.1043.

Kane, Tim J., “The Importance of Startups in Job Creation and Job Destruction.” SSRN Electronic Journal, July 2010, https://doi.org/10.2139/ssrn.1646934.

Davis, Steven J, et al, “The Flow Approach to Labor Markets: New Data Sources and Micro–Macro Links,” Journal of Economic Perspectives, vol. 20, no. 3, 2006, pp. 3–26., https://doi.org/10.1257/jep.20.3.3.

Balu, Nivedita, “Salesforce to Cut 10% of Workforce after Hiring ‘Too Many People,’” Reuters, Thomson Reuters, 4 Jan. 2023, https://www.reuters.com/technology/salesforce-cut-staff-by-10-close-some-offices-2023-01-04/.

Strauss, Delphine, “Generative AI Set to Affect 300MN Jobs across Major Economies,” Financial Times, 27 Mar. 2023, https://www.ft.com/content/7dec4483-ad34-4007-bb3a-7ac925643999.

Turner, Jack, “Tech Companies That Have Made Layoffs in 2023,” Tech.co, 4 Apr. 2023, https://tech.co/news/tech-companies-layoffs.

Menezes, Saksha, “Apple (AAPL) Avoids Tech Layoffs Because It Didn't Overhire like Google, Amazon,” Bloomberg.com, Bloomberg, 10 Feb. 2023, https://www.bloomberg.com/news/articles/2023-02-10/apple-aapl-avoids-tech-layoffs-because-it-didn-t-overhire-like-google-amazon.

Marr, Bernard, “The Real Reasons for Big Tech Layoffs at Google, Microsoft, Meta, and Amazon,” Forbes, Forbes Magazine, 30 Jan. 2023, https://www.forbes.com/sites/bernardmarr/2023/01/30/the-real-reasons-for-big-tech-layoffs-at-google-microsoft-meta-and-amazon/?sh=ca8fee92b67d.

Rangan, Yamini, “A Message from HubSpot CEO Yamini Rangan,” HubSpot, HubSpot, 31 Jan. 2023, https://www.hubspot.com/company-news/a-message-from-hubspot-ceo-yamini-rangan.

Ozdenoren, Hakki, “You Got Laid off. What's next?,” Revelio Labs, Revelio Labs, Inc., 20 Dec. 2022, https://www.reveliolabs.com/news/macro/you-got-laid-off-what-is-next/.