# The Impact of the COVID-19 Pandemic on Framingham Businesses

April 9, 2020

By Hope Goodman
Advised by Professor Kiel

## Introduction

In today's global economy, an economic crisis can have much more far-reaching effects than it might have fifty years ago. Given the increasing nationalization and globalization of supply chains in various industries, as well as the rise of e-commerce, the U.S. economy has become increasingly vulnerable to foreign as well as domestic crises such as a pandemic. Beginning in March of 2020, the U.S. economy took a drastic turn for the worse when a rapidly spreading and highly contagious novel coronavirus, labeled COVID-19, prompted nationwide lockdowns in almost every developed country. As businesses deemed non-essential shut their doors and the stock market plummeted, society was plagued with fear and uncertainty as citizens attempted to discern between disinformation and scientific advice about how to best avoid, identify, and treat the virus. At the same time, local and state governments were attempting to navigate how to best avoid economic ruin while also prioritizing public health and safety.

As an industrial metropolitan area near Boston, the city of Framingham exemplifies a local government that wanted to help its businesses survive this unprecedented time. With more than 1,500 businesses across a plethora of industries and sizes, Framingham's economy represents a great area for analysis of how many different types of businesses are faring financially during the pandemic. Through my creation of a COVID-19 business survey, I collected relevant data from a subset of 115 of these businesses in order to determine what aspects contribute to a firm's resilience during an economic crisis such as the pandemic. I will also discuss pertinent literature regarding the state of firms during COVID-19, as well as how the incorporation of transportation costs into the profit maximization model has affected firm decisions during the pandemic. Ultimately, my study finds that businesses within this small city follow nationally observed trends, which largely indicate that professional services firms are

faring well while firms in the food service, retail, and wellness industries are disproportionately struggling. Since the pandemic took effect in the U.S. in March, the literature on the economic impacts of coronavirus has rapidly grown, but it is helpful to first consider the existing literature on the issues which firms are now facing.

## Literature Review

### I. Supply chain issues

With the United States' increasingly global economy, the coronavirus pandemic has caused supply chain disruptions for numerous firms. This outcome was not unexpected, as previous economic papers consider the breakdown of supply chains from crises such as other pandemics and natural disasters. Kumar and Chandra (2010) modelled the impact of an avian flu pandemic on annual sales and global supply chains of a hypothetical large retailer and computer manufacturer. The study found that the supply chain would be disrupted by workers falling sick and firms unable to operate under a lockdown. Such a disruption would lead to a drop in sales from the firms being unable to sell a finished product, and ultimately, customers may switch to competitors with an undisrupted domestic supply chain which would result in longer-term financial losses for these firms. However, while Bonadio et. al (2020) estimate that one-third of the average downturn in the U.S. GDP due to a pandemic would be due to global supply chain disruptions, they argue the average drop in GDP would have been slightly bigger with domestic supply chain disruptions due to unilateral lockdown policies.

Hiroyasu and Yasuyuki (2017) simulate the supply chain effects from a natural disaster using comprehensive data on Japan's nationwide supply-chain network. An important finding from this paper is that firms physically unaffected by natural disaster can still be afflicted

through the "ripple effect" of supply chain disruptions through the firms' networks. Furthermore, they argue that when a firm can more easily substitute suppliers, the firm's indirect effects through the supply chain network can be mitigated more effectively. For instance, a firm in the U.S. that relies on an input which multiple local suppliers make would mitigate its effects more effectively than a firm which relies on an input which it only sources from China. Hiroyasu and Yasuyuki (March 2020) also studied the supply chain effects of a lockdown in Tokyo due to COVID-19. Similar to their 2017 paper, they find that the shutdown of firms within the city would cause ripple effects throughout the complex supply chain networks which Tokyo supports. They also conclude that after one month of lockdown, the economic losses outside of Tokyo would be twice as large as within the city itself, implying that "the effect of a longer lockdown can reach firms that are "farther" from Tokyo along supply chains" (Hiroyasu and Yasuyuki 7). This preliminary finding can be extrapolated to the numerous cities in the U.S. and overseas which comprise a global supply chain network.

## II. Labor supply

Along with severe supply chain disruptions, COVID-19 has also resulted in a negative shock to labor supply, a contributing factor to the disruption of supply chains. As described by Bloom et. al (2005), "a pandemic will affect the availability of labor as illness will force many workers to stay home" (3). Furthermore, many industries, mainly within the service and manufacturing sectors, rely on workers who cannot complete their work from home, and therefore were faced with a major decrease in labor supply in the early months of the coronavirus pandemic when workers could not come into the workplace. Del Rio-Chanona et. al (2020) discuss the magnitude of this labor supply shock in China, the first country to impose a strict lockdown in early 2020 and an important factor in many firms' supply chains, especially in the

U.S. When the Trump administration deemed a broad swath of businesses "essential" and therefore allowed to remain open, this labor shortage was partially solved. However, del Rio-Chanona et. al also emphasize that 21 percent of workers in the U.S. were neither part of an essential business or able to work from home and found themselves out of work as a result (12). They also argue that, in most industries, the negative shock to labor supply will eventually be dwarfed by a fall in labor demand, as decreased consumer demand in many industries due to the pandemic leads firms to reduce demand for labor.

## III. Decreased consumer demand

Decreased consumer demand is expected during times of economic crisis, but studies during previous pandemics can help explain why this decrease is especially pronounced during public health crises. In the context of the avian flu pandemic, Bloom et. al model the potential impacts on demand using variables very similar to the actual case amount, lockdown time period, and fatality rate of COVID-19. Aside from lockdowns physically preventing people from consuming, the authors predict the significant drop in consumer confidence due to the fear and uncertainty caused by the pandemic will significantly decrease consumption as well as investment. The U.S. saw consumer confidence drop more than 30 points from February to April of 2020, as coronavirus took hold of the country ("Economic Indicators"). Moreover, "markets have a tendency to overreact, which could exacerbate the economic impact," further suppressing consumption and investment and reducing demand across industries (Bloom 3). During the SARS outbreak, Fan (2003) observes the drastic drop in consumer demand in the tourism, transportation, dining and retail industries, as "consumers shun shops, restaurants, and entertainment venues; and travelers cancel trips," trends which have also been observed throughout the coronavirus pandemic (3). The paper also discusses the reduction of import

demand by Asian economies due to the SARS outbreak mainly affecting this part of the world. With a global pandemic such as COVID-19, this reduction in import demand will likely be experienced by nearly all countries affected.

## IV. Increased uncertainty

A major cause of this decreased consumer and firm-level demand stems from the increased uncertainty and fear caused by a pandemic. For instance, Fan describes the rapid decline of consumer confidence in Asia in the wake of the SARS outbreak stemming from the uncertainty and fear incited by the lack of public knowledge about it in the early stages of the outbreak. Both Fan and Bloom et. al highlight the importance of governments taking action to spread accurate and complete information and actively curb the spread of disinformation, because inciting fear and uncertainty will only exacerbate economic and psychological effects and can lead to a "degree of overreaction in some cases" (Fan 5). Fan also argues that pertinent information that needs to be communicated to the public regarding a public health threat displays the characteristics of a public good while the disease itself causes negative externalities, two areas where market failures typically occur and require government intervention to be corrected.

Therefore, "targeted and aggressive public health responses need to be combined with a rational evaluation of risks so as to minimize disruption to people's lives," as well as provide full information to consumers, employers, and other market players which require full information to make well-informed and safe decisions (Fan 6). As the U.S. has witnessed in other countries during COVID-19, "The accurate, timely, and transparent provision of information...by governments is critical for containing the epidemic and reducing public fears and uncertainty," thus encouraging consumer confidence and demand (Fan 7). Previous public health crises have

shown that through the promotion of public health safety protocol backed by scientific evidence and the suppression of disinformation, uncertainty and fear can be effectively reduced.

## V. COVID-19 pandemic

Thus far, I have predominantly discussed economic literature that was published prior to the coronavirus pandemic regarding economic issues as a result of public health crises. There has also been an impressive breadth of literature, both working and published, drafted since the pandemic began in early 2020. Ding et.al (2020) consider how certain factors affect "corporate immunity" to the pandemic, finding, significantly, that firms with international supply chains and customers abroad saw an increased fall in stock prices as compared to those with domestic supply chains and customers (Ding 30). Furthermore, Gourinchas et. al (2020) use a cost-minimization model to estimate the impacts of COVID-19 on business failures of small to medium-sized firms (SMEs) using firm-level data from 17 countries in Europe. Allowing demand, supply, and worker productivity shocks to vary across sectors deemed essential and non-essential, the authors estimated a nine percent increase in the failure rate of SMEs without government intervention. They found the most affected industries to be "Accommodation & Food Services, Arts, Entertainment & Recreation, Education, and Other Services" (Gourinchas abstract). Finally, Fairlie (2020) discusses the disproportionate effects of the pandemic on women and minority-owned small businesses using data from the Current Population Survey in April 2020. Alarmingly, the author found that the number of operating women-owned businesses dropped by 25 percent, while black, immigrant, and Latinx-owned businesses dropped by 41, 36, and 32 percent from April 2019 to April 2020, respectively (Fairlie 5).

Though I find the aforementioned papers to be valuable contributors to the COVID-19 literature, a study done by Bartik et. al (2020) provided particularly direct information regarding the current state of small businesses, as they are generally the most at risk of permanent closure during economic crises. Bartik et. al (2020) sent out a survey to small businesses all over the U.S. in April 2020 and received more than 5,800 responses. Their survey included 43 questions, including information about firm characteristics such as firm size and industry, their current experience and response to the COVID-19 crisis, and beliefs about their future ability to remain open (Bartik 5). The researchers found that, at the time, employment declines exceeded 50 percent in many industries such as retail, arts and entertainment, personal services, food services, and hospitality businesses, similar to the industries which Gourinchas et. al found to be the most affected (8). Conversely, Bartik et. al observed that surveyed firms in professional services sectors such as banking, finance, law, and real estate, as well as the construction sector, were not as severely impacted by COVID-19 due to these industries' ability to adapt to remote or socially distanced work (9). Finally, this survey also concluded that less than half of surveyed businesses expected to remain open if the pandemic lasted four months past April instead of one month, of which three-quarters of respondents expected to survive (14).

Bartik et. al collected relevant data points from their nationwide business survey. I am seeking to contribute to the COVID-19 business survey literature by utilizing more comprehensive survey data from a densely populated metropolitan area outside of Boston. Regarded as an industrial hub in New England, the city of Framingham is home to around 70,000 people and over 2,500 businesses which effectively represent a variety of industries. Furthermore, given Framingham's proximity to Boston, several major corporations are headquartered here, while small and medium-sized businesses are abundant. Given

Framingham's diverse business makeup, I believe it will closely align with the experiences many businesses across the country have been experiencing due to the pandemic. In addition, the survey data I have collected will provide crucial additional data points compared to Bartik et. al, such as pre-COVID-19 business conditions, number of employees and years in business, and estimated revenue change since March. I will also seek to add to the COVID-19 literature by utilizing regression analyses to control for other variables which may be affecting the conclusions drawn from business surveys.

## Data

This analysis will utilize survey data collected from 115 businesses in Framingham, Massachusetts. Given the nature of survey data, most of the data is qualitative rather than quantitative. Through an ongoing internship with the Economic Development and Industrial Corporation (EDIC) for the City of Framingham, I had the opportunity to develop and communicate a 30-question survey to roughly 1,500 local businesses. We utilized the survey platform Typeform to develop the different types of survey questions, and created a master database of businesses' contact information by merging the business contacts from Framingham's ACT and D-U-N-S databases. The survey was primarily communicated to businesses via email, but some preferred to complete it over the phone.

The survey questions collected a firm's basic contact information as well as general information such as type of industry, number of years in business, number of employees, and whether it is women- and/or minority-owned. Most importantly, the survey included questions regarding COVID-19 such as estimated percent change in revenue, number of employees laid off, issues with employee absences, and supply chain disruptions. The percent change in revenue will serve as the dependent variable in my study. In relation to COVID-19, we also asked for the

general locations of a firm's employees, customers, and suppliers. Furthermore, the original version of the survey sent to businesses via email included eight ratings questions regarding their satisfaction with the city's services such as public safety, internet, licensing, etc.

As a result of receiving only 60 responses after sending just under 1,000 emails to businesses during July and August, I suggested we omit the repetitive ratings questions from the survey to increase the response rate. After the survey was shortened, we received another 60 responses in just one month and had to omit only a few duplicate surveys received from the same business, for a total of 115 viable survey responses. The business survey data effectively represents many different industries in Framingham, from restaurants to manufacturing to professional services, which allows the findings from this study to be more effectively extrapolated to other metropolitan areas. I narrowed the businesses into six industry categories: retail, restaurants, professional services, education and wellness, manufacturing, and utilities. Professional services accounted for 32 percent, followed by retail at 27 percent, restaurants at 13 percent, and the other three categories were each represented by roughly ten percent of respondents. Of the 115 businesses, 65, or 57 percent, qualified as an "essential" business throughout the pandemic, which I then added as another variable to my dataset.

## Model

### I. Profit maximization

For my analysis of firms in Framingham, I will be focusing on the profit maximization model of economics, based on the assumption that all firms seek to maximize profits. The difference between a firm's total revenue (TR) and total costs (TC) will equal the profit of that firm, as displayed by Equation 1 below.

(1) $\pi$ = TR - TC

Furthermore, according to the model, firms will maximize profit by producing a quantity of output where marginal revenue is equal to marginal cost (O'Sullivan 80). The survey data collected for this study will better explain firms' changes in total costs rather than total revenue, though the COVID-19 pandemic has certainly affected both. The standard profit maximization model only reflects a change in total cost caused by a change in quantity or price of inputs. In reality, however, a firm's costs are also affected by the transportation costs of its inputs, outputs, and workers, which reflects the spatial aspect of a firm's ability to profit maximize. Before we can assume that a firm "maximizes its profit by minimizing its transportation costs," we must consider the assumptions held constant to establish the validity of this statement (66).

## II. The monocentric city

Though today's cities are not monocentric, the concept of transportation costs was originally established in tandem with the model of the monocentric city. The monocentric model "incorporates the interactions between the urban land market and the urban labor market" within a city that revolves around one center, hence the name of the model (210). To establish the model, there are four assumptions. The first is that manufacturing firms export their output through a central export node, such as a port or terminal. Second, these firms use horse carts to move their output from the factory to the export node. Third, workers travel by car from their homes to their jobs in the central business district. Lastly, the output of office firms in information, so office workers travel between firms to facilitate central information exchange among office firms (210). With the monocentric model and its assumptions established, we can now demonstrate how firms profit maximize by minimizing transportation costs.

## III. Transportation costs

As previously discussed, the increasingly non-local economies of many U.S. firms have frequently resulted in national and global supply chains, especially for medium and large-sized firms. Globally, decreasing transportation and production costs have allowed firms to decrease the transportation costs of inputs and outputs and allowed them to both source and sell their products to a much larger region (72). Equation 2 demonstrates how transportation costs modify the traditional profit maximization equation for a business.

$$(2)\ \pi = \frac{\text{Total revenue} - \text{Freight cost}(x) - \text{Labor cost}(x) - \text{Intermediate input cost}}{T}$$

In this equation, total revenue remains the same. Total costs, however, are separated into freight costs, labor costs, and intermediate input costs, where *x* represents units of distance. The difference between these costs and revenue is then divided by *T*, the quantity of land occupied by the business. By incorporating transportation costs into how firms maximize their profits, one can better understand how differing needs across industries result in uneven expenditures on land and nonland expenses.

Consider a manufacturing firm as an example. Figures 1 and 2 provide a visual representation of how a manufacturer's labor costs compare to freight costs, the costs associated with transporting inputs and outputs, and how these costs change with distance from the city center (146). Figure 1 depicts a manufacturer's costs prior to the advent of trucks and other technology which greatly reduced freight costs. Since 1955, improved technology and increased efficiency in air cargo transportation caused shipping costs per ton to drop more than tenfold, and the introduction of standardized shipping containers in the 1960s "cost savings by allowing goods to be packed once and moved over long distances via a variety of transport modes--truck,

rail, ocean liner, rail, then truck again--without being unpacked and repacked" (Hummels 8, 11). With these improvements in mind, the slope of the freight cost curve in Figure 2 is much flatter and substantially lower than the labor cost curve.

Consequently, and significantly, the firm's total cost curve changes from upward-sloping in Figure 1 to downward-sloping in Figure 2, meaning the manufacturer will actually be more profitable further away from the city center. For this reason, manufacturers will maximize profits by allocating costs towards expenses other than land through factor substitution while office firms will ultimately out-bid manufacturers for land closest to the city center. The manufacturing firms dealing with tangible inputs and outputs will have more complex supply chains than those in office buildings, and will therefore be more vulnerable to changes in the prices and freight costs of inputs and outputs. On the other hand, firms in office spaces will be more affected by changes in labor costs, or transporting their workers to and from work.

Office firms will also choose to locate near the city center in order to reap the benefits of agglomeration economies, such as knowledge sharing and common labor pools, and to facilitate central information exchange. As opposed to other types of firms, "the office industry has more to gain from proximity to the city center" and will therefore outbid firms in other industries for land in downtown areas (213). Though the cost of land is higher, firms in the professional services arena such as "bankers, accountants, financial consultants, marketing strategists, product designers, and lawyers" exchange tacit information that is considered the input and output for these firms. As a result, firms are incentivized to "reduce travel time for interaction by locating close to related firms," especially considering the high opportunity cost of travel time for these high-skilled workers (155). However, firms in these downtown office spaces will have to compensate their workers for the additional time and money spent on commuting, so their

workers' wages will reflect their commuting costs as well as the firm's willingness to pay for office space (158). For instance, as a densely populated industrial hub, many office workers commute from the suburbs to downtown Framingham by car, and some survey respondents even lamented about the traffic they encounter getting to and from work every day. Therefore, for firms using office space, the transportation costs of their workers will account for a majority of the firms' transport costs. For firms relying more heavily on transporting inputs and outputs, such as manufacturers, they are more likely to allocate funds towards these costs, or "factor substitute" away from higher-priced land and the accompanying higher wages.

## IV. Pandemic-induced changes

Within the context of the profit maximization model, the question remains of which types of firms could successfully maintain a profit during the pandemic. With the onset of the COVID-19 shutdown, firms' revenues, costs, and therefore profits, began to change dramatically. Depending on the industry, firms across different sectors were affected differently by changes in the economy and everyday life due to the pandemic. For instance, firms in the service sector, such as restaurants and retailers, previously relied almost completely on in-person interactions with customers. Because the vast majority of firms in the service sector were not deemed essential businesses, they were forced to temporarily close their doors to in-person business. Inevitably, service sector firms faced a drop in revenue, but the magnitude of this drop was determined by each firm's ability to conduct business without in-person interaction (Gourinchas). Furthermore, decreased revenues combined with increased spending on employee health and safety led service sector firms to minimize costs via employee layoffs at a disproportionate level compared to other sectors (Dey). In Figure 3, such industries relying

heavily on in-person services such as “Food services and drinking places” as well as “Child care services” endured 45 and 30 percent decreases in employment, respectively.

Conversely, most firms in the manufacturing sector were deemed essential businesses, especially if they were capable of temporarily manufacturing personal protective equipment in addition to or instead of their normal products. However, manufacturers faced supply chain issues, and, unlike the professional services sector, manufacturing largely requires its workers to be on-site but manufacturers often could not have more than sixty percent of their workforce on-site at once in order to adhere to social distancing guidelines (Kroupenev). Based on a survey of 150 major manufacturers in June, those which had already furloughed employees had done so at a rate higher than the “white-collar” professional services sector, but lower than the “blue-collar” service sector (Levanon). This finding is supported by Figure 3, which shows that the manufacturing sector decreased employment by around ten percent. As lockdowns eased during the summer months, supply chain issues and consumer demand improved, and manufacturers were able to employ some workers off-site and others on-site.

Overall, firms in the professional services sector, including but not limited to law, accounting, consulting, and financial services firms, were the least disrupted by the pandemic. Though these businesses are typically located in city centers or otherwise densely populated urban areas, as previously discussed, workers in these industries were able to quickly pivot to teleworking. According to the Bureau of Labor Statistics, as of July, 58 percent of workers in professional services were teleworking, compared to just seven percent of those in the service sector (“Supplemental Data”). As a result, the revenues of professional services firms did not drop as severely as those in other sectors, if at all, and some of their costs may have actually decreased. With employees no longer commuting to and from work, firms have reported higher

productivity as employees work during time previously spent commuting, and some firms have stopped paying office rent as they move to telework for the foreseeable future. Referring to Figure 3, we can see that professional services sectors represented by “Professional and technical services” and “Finance and insurance” have experienced very minimal change in employment since February with five and zero percent decreases, respectively. By analyzing my business survey data, I will determine whether the profitability of represented industries within Framingham correspond to the observed national industry trends during the pandemic thus far.

## Methodology

### I. Independent variables

Basing my analysis on the profit maximization model and firms’ differing transportation costs, I will consider the wide-ranging impacts of the pandemic across industry sectors and business sizes by setting my dependent variable as the percent change in revenue experienced by firms in Framingham. Using an ordinary least squares regression will allow me to derive the explanatory power of each of my independent variables on the dependent variable, while all others are held constant. Table 1 shows the dependent and independent variables derived from the survey data as well as variable descriptions, where (1/0) indicates a dummy variable. Table 2 depicts the descriptive statistics for all variables, with the means proving most useful for categorical variables. I also used a correlation matrix to determine the possibility of correlation between any variables.

### II. Regression

In my first estimation of Equation 1 below, I include all 18 independent variables derived from Table 1, with the estimation displayed in Table 3.

$$(1)\ Y = \beta_1(retail) + \beta_2(restaurant) + \beta_3(prof\_service) + \beta_4(educ\_wellness) + \beta_5(manufacturing) + \beta_6(minority\_owned) + \beta_7(women\_owned) + \beta_8(yrs\_open) + \beta_9(expand\_prior) + \beta_{10}(hours\_affected) + \beta_{11}(\_employees) + \beta_{12}(emp\_layoffs) + \beta_{13}(local\_customer) + \beta_{14}(emp\_absence) + \beta_{15}(local\_supplier) + \beta_{16}(supply\_issues) + \beta_{17}(essential) + \beta_{18}(opp\_zone)$$

These initial results indicate that the restaurant and education and wellness industries are statistically significant variables at the five percent level, as well as the number of employees and whether a business is essential. However, given that only two of five industry dummy variables were significant, I completed an F-test of the industry variables to test whether industries as a group would affect my model. Table 4 shows that with an F-value of 0.0005, the group of industry variables is indeed statistically significant at the 5 percent level. Table 5 also demonstrates that a regression run without any industry variables results in a decrease of the adjusted R-squared by roughly 30 percent, reinforcing the significance of industry in determining the dependent variable. To improve the explanatory power of my variables, I gradually eliminated those that were the most statistically insignificant as deemed by the t-statistics in my regression results, though other studies, such as Bartik et. al, have found these variables to be significant. The variables removed determined whether a business is minority and/or women-owned, expanded prior to the pandemic, has local customers and/or suppliers, has laid off employees and/or struggles with employee absences, and whether a business is in an opportunity zone. After removing these, my final regression includes ten variables. Table 6 demonstrates the variables ultimately used in the multivariate linear regression to estimate the dependent variable *Y*, the estimated percent change in revenue of firms in Framingham.

The first five independent variables are dummy variables controlling for potential differences across industries, where five dummy variables are included to account for six total industry categories, with the sixth being *utilities*. *Yrs_open* and *_employees* are quantitative independent variables. Finally, the variables *minority_owned*, *women_owned*, *expand_prior*, *emp_layoffs*, *emp_absence*, *local_customer*, *local_supplier*, *supply_issues*, *hours_affected*, *essential*, and *opp_zone* all represent categorical variables describing the firm, where a value of 1 indicates "yes" or "true," and 0 indicates "no," or "false." The first three variables indicate whether a firm is minority-owned, women-owned, or expanded prior to the pandemic, while the next three specify whether a firm has laid off any employees since March, has experienced employee absences since March, or has local customers, respectively. The following three variables indicate whether a firm has local suppliers, has experienced supply chain issues since March, or has changed their business hours of operation. Finally, the last two variables stipulate whether a firm was deemed essential during the pandemic, or if a firm exists within a designated "opportunity zone," defined as an area "where firms pay low taxes, receive subsidies for worker training, and are exempt from some local regulations" (O'Sullivan 123).

## Results

According to the regression model displayed by Table 6, five independent variables have a statistically significant effect on *Y*, the estimated percent change in revenue, at the five percent level. Two of these significant variables are the industry categories of restaurants and education & wellness. To accurately interpret the coefficients of the industry variables, I remind the reader that I derived six industry categories from the data and thus included five dummy variables in the regression. The sixth industry category, utilities, serves as a reference point for these variables. With a mean decrease in revenue of six percent without holding anything else constant, the

utilities industry represents a logical choice as a reference for other industries. For instance, with a coefficient of -44.18, a firm in the restaurant industry will experience an additional 44 percent decrease in revenue compared with a utility company. Similarly, a firm in the education and wellness industry will lose an additional 29 percent in revenue. Examples of such education businesses include preschools, childcare centers, and music and dance schools, while the wellness industry includes a variety of businesses from tanning salons to counseling services. Relying mainly on in-person interactions, these firms have likely been operating at substantially reduced capacities since March, if at all. As another traditionally in-person industry, the retail industry variable indicates a 17 percent additional loss in revenue, albeit at a 16 percent significance level. Given the small sample size of my dataset, even at this significance level, this variable should still be considered relevant. Observing Figure 3, the percentage change in employment reported by each aforementioned industry corresponds closely with the respective percent decreases in revenue reported here.

Whether business hours have been affected by the pandemic also has a statistically significant effect on a firm's change in revenue. On average, firms that reduce their business hours will experience a further 12 percent revenue loss compared to firms that maintain their normal business hours. The majority of businesses reducing their business hours likely rely at least partially on in-person interaction, including those in aforementioned industries such as restaurants and retail. Furthermore, the coefficient on number of employees indicates that each additional employee will cause a decrease in a firm's revenue by 0.1 percent, meaning an added revenue loss of one percent for each 10 additional employees. Of the 115 surveyed firms, 24 report having 30 or more employees, 14 have 50 or more employees, and nine have 100 or more,

resulting in three, five, and ten percent added revenue decreases, respectively. In contrast, the model shows that being deemed an essential business will boost a firm's revenue by 15 percent.

## Discussion

Overall, with a relatively low adjusted R-squared of 0.2663, the model does not fully explain the variation in a firm's percent change in revenue since March. However, though not a perfect fit for the data, the model indicates that factors such as industry appear to play a major role in a firm remaining profitable throughout the pandemic. Additionally, though a firm's number of employees is statistically significant as a result of my regression, I do not consider the measure to be a highly economically significant variable. Due to the fact that many more small businesses than large corporations tend to be struggling during this pandemic, I conclude that this measure is slightly skewed because of the sample size and high variance in number of employees. In contrast, whether a firm's hours were affected during the pandemic is an economically significant variable in determining a firm's change in revenue, as it is correlated with a firm's industry and whether they can adequately service customers.

Given the modest sample size of businesses and the uncertain nature of the economy and public health, I did not expect my survey data to completely explain the dependent variable. Furthermore, with a mean of -26 percent and a standard deviation of 35 percent, the dependent variable indicates a high level of variance and therefore points to the possibility of numerous variables that could potentially affect *Y* (see Table 7). Instead, my model better demonstrates how different industries in a business hub such as Framingham compares with national business trends. Through my collection and analysis of survey data from 115 businesses in Framingham,

this study contributes to the growing COVID-19 literature by considering firms in one city as opposed to a sampling of firms across the U.S., or multiple countries. Moreover, though my findings are limited to a relatively small sample size, my analysis corroborates results found in larger surveys, namely being the industries that are most struggling with revenue loss. This corroboration indicates this is likely the case in many other cities and towns nationally and internationally, meaning primarily in-person industries such as food and drink services, education, wellness, and retail would most benefit from direct financial stimulus until pandemic-induced restrictions can be safely lifted. An important takeaway from my study is that a business' ability to survive and remain profitable through the entirety of this public health crisis will be determined almost entirely by the industry of the business.

## Conclusion: Moving Forward

Accounting for these industry differences, economic experts believe a "K-shaped" economic recovery is beginning to take shape and will continue after the pandemic ends for the foreseeable future (Jones). A "K-shaped" economic recovery occurs when certain industry sectors have divergent trajectories following a crisis such as the COVID-19 pandemic. What has most differentiated these two trajectories of a business is whether it can realistically pivot its employees to working from home. The sectors that have successfully made this transition, such as firms in professional services, will likely follow an upward curve after the pandemic since the majority have been minimally impacted throughout the pandemic, or have even benefited financially. Not only have these businesses successfully continued working around full capacity, but they have also substantially reduced labor costs by having employees work from home, and they are not afflicted by any supply chain issues due to the intangible nature of their work. If some firms decide to make a long-term transition to working from home, this will further

improve their economic trajectory by reducing costs and increasing profits. Unsurprisingly, this sector has maintained the lowest rate of business closures since February, with two businesses closed out of every one thousand (Bialik and Gole).

Conversely, due to the nature of many other industries, working from home is simply not a viable option and economic recovery will follow a slower and more difficult trajectory. Though some businesses in these industries were deemed essential and therefore allowed to remain open, those relying heavily on in-person customers continue to be severely limited by pandemic restrictions. As of December 2020, nine months after the national pandemic-induced lockdown, businesses in eight states are "mostly closed," and twelve additional "mixed" states have closed some businesses by sector (Lee et. al). According to a September report released by Yelp, Figure 4 shows the industries of restaurants, retail, and wellness have reported the highest number of permanent business closures, coinciding with the industries which my study determined to have the largest drops in revenue (Bialik and Gole).

Furthermore, businesses in these and other industries which continue to operate in-person incur additional costs that are avoided by firms working from home. These costs can include, but are not limited to, hazard pay for employees working during a pandemic, additional cleaning and sanitization measures, infrastructure modifications to allow for social distancing and ventilation, and transportation costs. The latter cannot be avoided by firms which are continuing to operate in person because employees must still be compensated for their commuting costs, and hazard pay may further increase this labor cost. Increased transportation costs can also come as a result of supply chain disruptions, such as those discussed in the literature, that require more time, employees, money, or infrastructure to solve. Ultimately, considering the model of profit

maximization, the industries enduring increased costs and decreased revenue will almost certainly have a difficult economic recovery assuming the businesses survive the pandemic.

Considering the staggering number of business closures already reported in at-risk industries, it is imperative that the next government stimulus package, when or if it occurs, supports the businesses that need it most. Data on the first package, which included funding for businesses via the Paycheck Protection Program, showed "more than half of the $522 billion…went to bigger businesses, and only 28 percent of the money was distributed in amounts less than $150,000" (O'Connell). This finding indicates the majority of the money did not reach small businesses, which Bartik et. al determined to be at great risk of permanent closures. Furthermore, professional services firms that have fared relatively well during the pandemic were among the recipients of $10 million loans, the maximum amount awarded to businesses. Due to this funding favoring big businesses "with established banking connections, smaller operations lost out on funding at a critical time," (O'Connell) especially considering the increase in business closures of 25 percent over the summer months, when this funding would have come out (Bialik and Gole). Moving forward, relevant findings from the current economic literature on businesses during COVID-19, such as those presented by this study, should be considered if the U.S. government is indeed confronted with an uneven K-shaped economic recovery in the coming years.

**Works Cited**

Bartik, Alexander W., et. al. "How Are Small Businesses Adjusting to COVID-19? Early Evidence from a Survey." *National Bureau of Economic Research Working Paper Series*, vol. 26989, April 2020, www.nber.org/papers/w26989.

Bialik, Carl, and Daniel Gole. "Yelp: Local Economic Impact Report." *Yelp Economic Average*, Yelp, Sept. 2020, www.yelpeconomicaverage.com/business-closures-update-sep-2020.html.

Bloom, Erik, et. al. "Potential Economic Impact of an Avian Flu Pandemic on Asia." *Asian Development Bank - ERD Policy Briefs*, ser. 42, Nov. 2005. *42*, www.adb.org/publications/potential-economic-impact-avian-flu-pandemic-asia.

Bonadio, Barthélémy, et al. "Global Supply Chains in the Pandemic." *National Bureau of Economic Research Working Paper Series*, vol. 27224, May 2020, doi:10.3386/w27224.

del Rio-Chanona, R.M. et al. "Supply and demand shocks in the COVID-19 pandemic: An industry and occupation perspective." *Centre for Economic Policy Research Press*, iss. 6, April 2020, cepr.org/content/covid-economics-vetted-and-real-time-papers-0.

Dey, Matthew and Mark A. Loewenstein, "How many workers are employed in sectors directly affected by COVID-19 shutdowns, where do they work, and how much do they earn?," *Monthly Labor Review*, U.S. Bureau of Labor Statistics, April 2020, doi.org/10.21916/mlr.2020.6.

Ding, Wenzhi, et. al. "Corporate Immunity to the COVID-19 Pandemic." *National Bureau of Economic Research Working Paper Series*, vol. 27055, April 2020, www.nber.org/papers/w27055.

"Economic Indicators: List By Category." *Trading Economics*, 2020, tradingeconomics.com/indicators.

Fairlie, Robert W., et. al. "The Impact of Covid-19 on Small Business Owners: Evidence of Early-Stage Losses from the April 2020 Current Population Survey." *National Bureau of Economic Research Working Paper Series*, vol. 27309, June 2020, www.nber.org/papers/w26989.

Fan, Emma. "SARS: Economic Impacts and Implications." *Asian Development Bank - ERD Policy Briefs*, ser. 15, May 2003. *15*, www.adb.org/publications/sars-economic-impacts-and-implications.

Gourinchas, Pierre-Olivier, et. al. “COVID-19 and SME Failures.” *National Bureau of Economic Research Working Paper Series*, vol. 27877, September 2020, www.nber.org/papers/w27877.

Hiroyasu, Inoue, and Todo Yasuyuki. “Propagation of Negative Shocks through Firm Networks: Evidence from Simulation on Comprehensive Supply Chain Data.” *RIETI Discussion Paper Series*, Mar. 2017, www.rieti.go.jp/en/index.html.

Hummels, David. “Transportation Costs and International Trade in the Second Era of Globalization.” *The Journal of Economic Perspectives*, vol. 21, no. 3, 2007, pp. 131–154. *JSTOR*, www.jstor.org/stable/30033738.

“Job Growth Continues to Slow, Impact Varies by Sector.” *The Conference Board*, The Conference Board, Inc., 6 Oct. 2020, www.conference-board.org/topics/natural-disasters-pandemics/COVID-19-April-Sept-Job-report.

Jones, Chuck. “Three Charts Show A K-Shaped Recovery.” *Forbes*, Forbes Magazine, 27 Oct. 2020, www.forbes.com/sites/chuckjones/2020/10/24/three-charts-show-a-k-shaped-recovery/?sh=23e21bd5305f.

Kroupenev, Artem. “What Will Manufacturing’s New Normal Be After COVID-19?” *IndustryWeek*, 21 Apr. 2020, www.industryweek.com/technology-and-iiot/article/21129334/what-will-manufacturings-new-normal-be-after-covid19.

Kumar, Sameer, and Charu Chandra. “Supply Chain Disruption by Avian Flu Pandemic for U.S. Companies: A Case Study.” *Transportation Journal*, vol. 49, no. 4, 1 Oct. 2010, pp. 61–73. *JSTOR*, www.jstor.org/stable/10.2307/40904915?refreqid=search-gateway:73553cc1e7e264e367716190b9416ae7.

Lee, Jasmine C., et. al. “See Coronavirus Restrictions and Mask Mandates for All 50 States.” *The New York Times*, The New York Times, 25 Apr. 2020, www.nytimes.com/interactive/2020/us/states-reopen-map-coronavirus.html.

Levanon, Gad. “COVID-19's Impact On Manufacturers: Expect More Layoffs, But Also More Working From Home.” *Forbes*, Forbes Magazine, 17 June 2020, www.forbes.com/sites/gadlevanon/2020/06/11/covid-19s-impact-on-manufacturers-expect-more-layoffs-but-also-more-working-from-home/?sh=5a9633213b9f.

O'Connell, Jonathan. “More than Half of Emergency Small-Business Funds Went to Larger Businesses, New Data Shows.” *The Washington Post*, WP Company, 4 Dec. 2020, www.washingtonpost.com/business/2020/12/01/ppp-sba-data/.

O'Sullivan, Arthur. *Urban Economics*. Ninth ed., McGraw-Hill, 2019.

"Supplemental Data Measuring the Effects of the Coronavirus (COVID-19) Pandemic on the Labor Market." *U.S. Bureau of Labor Statistics*, 20 Nov. 2020, www.bls.gov/cps/effects-of-the-coronavirus-covid-19-pandemic.htm.

*Figure 1:*

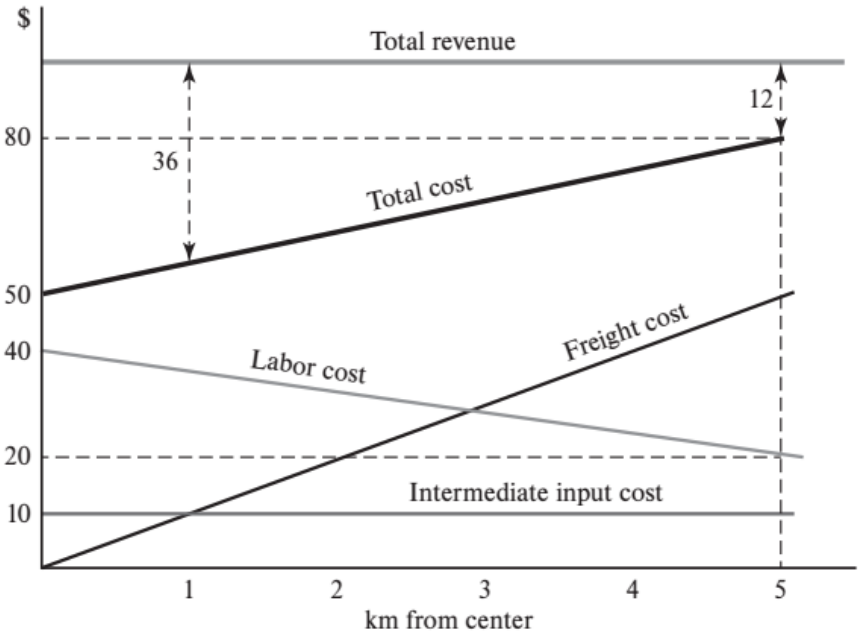


*Figure 2:*

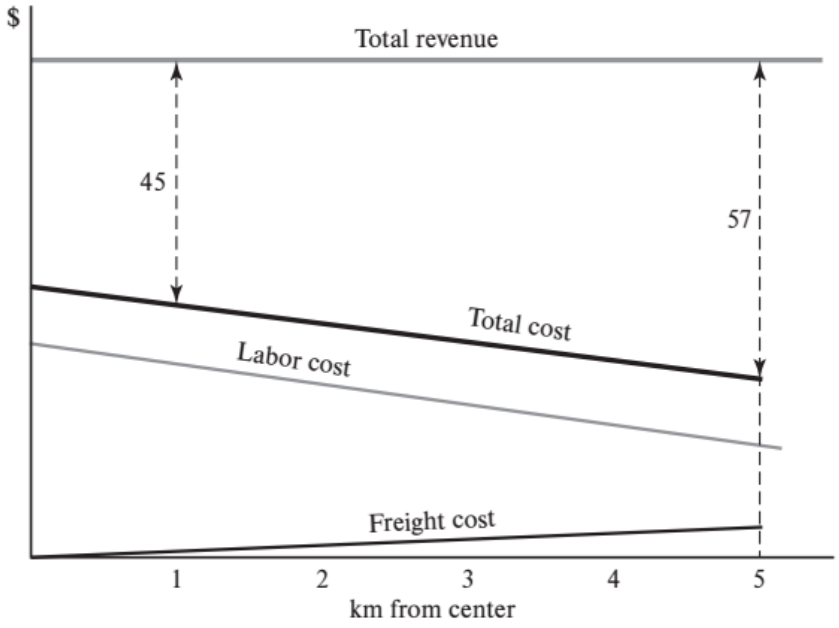

*Figure 3:*

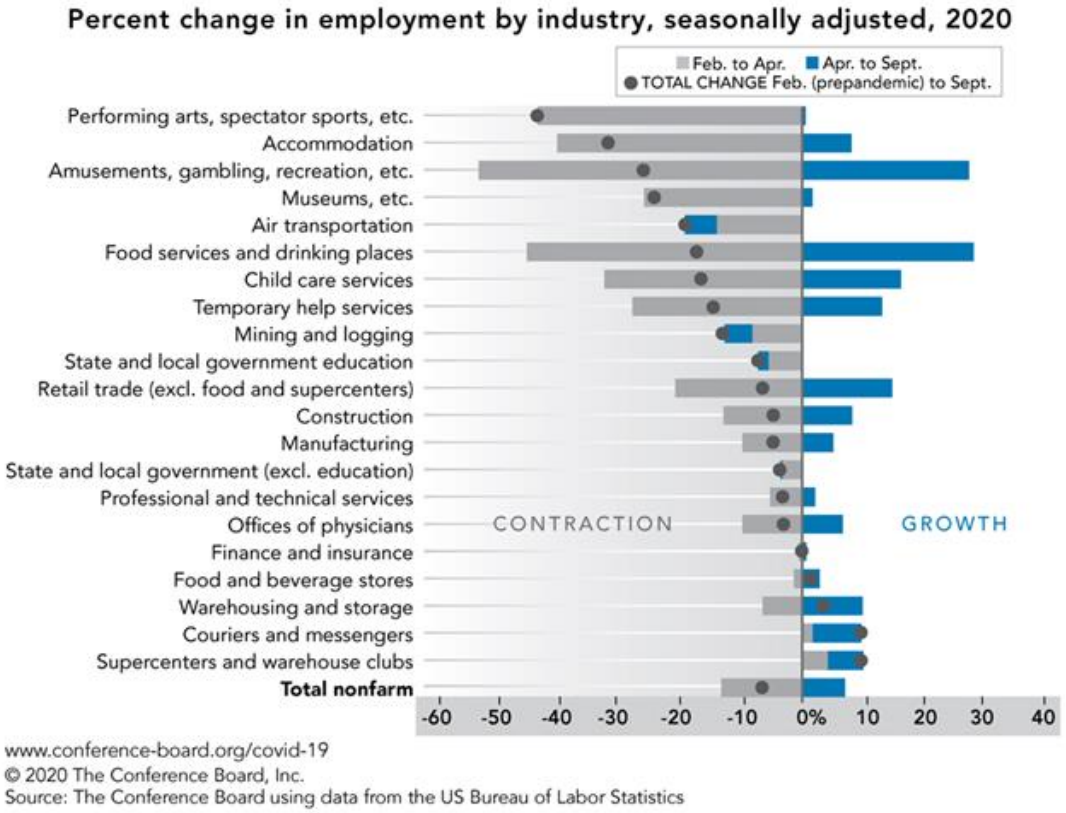


*Figure 4:*

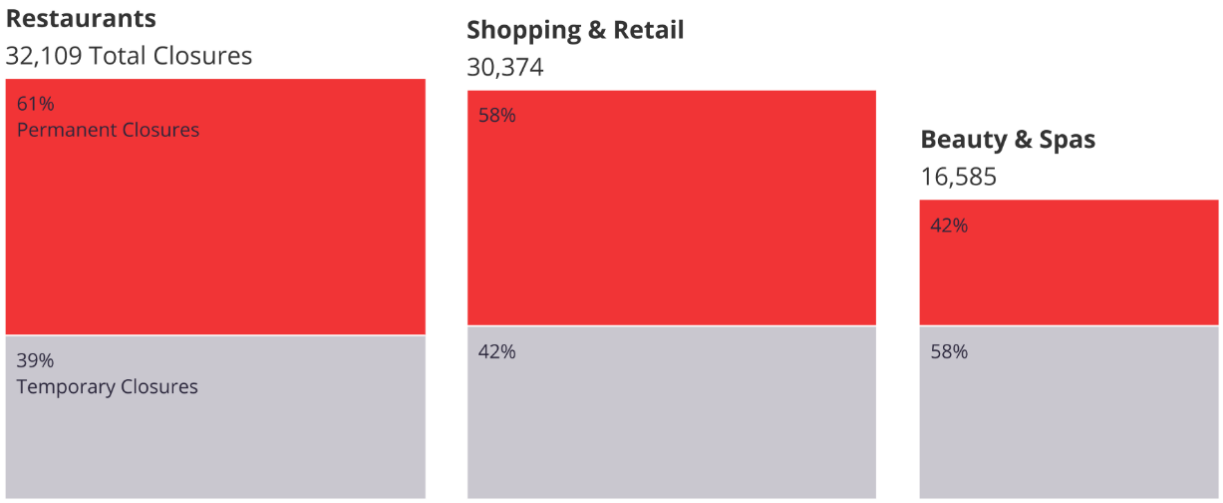

*Table 1:*

| Variable | Description |
|---|---|
| revenue_change (dependent) | Estimated percent change in revenue (%) |
| retail | Retail business (1/0) |
| restaurant | Restaurant business (1/0) |
| prof_service | Professional service business (1/0) |
| manufacturing | Manufacturing business (1/0) |
| utilities | Utility business (1/0) |
| minority_owned | Minority-owned business (1/0) |
| women_owned | Women-owned business (1/0) |
| yrs_open | Number of years in business |
| _employees | Number of employees currently employed |
| emp_layoffs | Number of employees laid off since March |
| expand_prior | Expanded prior to COVID-19 (1/0) |
| hours_affected | Percent change in hours of operation (%) |
| local_customer | Local Framingham customers (1/0) |
| local_supplier | Local Framingham suppliers (1/0) |
| supply_issues | Supply chain issues (1/0) |
| essential | Essential business (1/0) |
| opp_zone | In a Framingham “opportunity zone” (1/0) |
| emp_absence | Experiencing employee absences (1/0) |

*Table 2:*

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| retail | 115 | .2608696 | .4410306 | 0 | 1 |
| restaurant | 115 | .1304348 | .338255 | 0 | 1 |
| prof_service | 115 | .3217391 | .4691879 | 0 | 1 |
| educ_welln~s | 115 | .1217391 | .3284153 | 0 | 1 |
| manufactur~g | 115 | .0956522 | .2954008 | 0 | 1 |
| minority_o~d | 115 | .1391304 | .3475972 | 0 | 1 |
| women_owned | 115 | .2173913 | .4142761 | 0 | 1 |
| yrs_open | 115 | 17.53913 | 8.762247 | 2 | 25 |
| expand_prior | 115 | .6 | .4920419 | 0 | 1 |
| revenue_ch~e | 115 | -26.26087 | 34.76641 | -95 | 95 |
| hours_affe~d | 115 | .3913043 | .4901781 | 0 | 1 |
| _employees | 115 | 28.15652 | 65.88834 | 1 | 500 |
| emp_layoffs | 115 | 5.478261 | 37.59954 | 0 | 400 |
| emp_absence | 114 | .1842105 | .3893673 | 0 | 1 |
| local_cust~r | 115 | .6086957 | .4901781 | 0 | 1 |
| local_supp~r | 115 | .5304348 | .501257 | 0 | 1 |
| supply_iss~s | 115 | .4695652 | .501257 | 0 | 1 |
| essential | 115 | .5652174 | .4978979 | 0 | 1 |
| opp_zone | 115 | .1391304 | .3475972 | 0 | 1 |
| utilities | 115 | .0695652 | .2555263 | 0 | 1 |

*Table 3:*

```
. reg revenue_change retail restaurant prof_service educ_wellness manufacturing
>  minority_owned women_owned yrs_open expand_prior hours_affected _employees e
> mp_layoffs local_customer emp_absence local_supplier supply_issues essential
> opp_zone
```

| Source | SS | df | MS | | |
|---|---|---|---|---|---|
| Model | 47877.0683 | 18 | 2659.83713 | Number of obs | = 114 |
| Residual | 85148.5896 | 95 | 896.300943 | F(18, 95) | = 2.97 |
| | | | | Prob > F | = 0.0003 |
| Total | 133025.658 | 113 | 1177.21821 | R-squared | = 0.3599 |
| | | | | Adj R-squared | = 0.2386 |
| | | | | Root MSE | = 29.938 |

| revenue_ch~e | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| retail | -19.17288 | 13.2081 | -1.45 | 0.150 | -45.39427 | 7.048512 |
| restaurant | -42.48767 | 14.76526 | -2.88 | 0.005 | -71.80042 | -13.17492 |
| prof_service | -7.76452 | 13.193 | -0.59 | 0.558 | -33.95593 | 18.4269 |
| educ_welln~s | -30.61127 | 14.56839 | -2.10 | 0.038 | -59.53318 | -1.689363 |
| manufactur~g | -9.239457 | 15.35594 | -0.60 | 0.549 | -39.72484 | 21.24593 |
| minority_o~d | -6.507758 | 9.356119 | -0.70 | 0.488 | -25.082 | 12.06649 |
| women_owned | -5.724091 | 7.643809 | -0.75 | 0.456 | -20.89897 | 9.450788 |
| yrs_open | .3808158 | .3601985 | 1.06 | 0.293 | -.3342686 | 1.0959 |
| expand_prior | -4.707761 | 6.249063 | -0.75 | 0.453 | -17.11372 | 7.698196 |
| hours_affe~d | -10.32626 | 6.73201 | -1.53 | 0.128 | -23.69099 | 3.038471 |
| _employees | -.0968559 | .0466913 | -2.07 | 0.041 | -.1895499 | -.004162 |
| emp_layoffs | -.0820152 | .0825714 | -0.99 | 0.323 | -.2459402 | .0819097 |
| local_cust~r | -3.961845 | 6.833915 | -0.58 | 0.563 | -17.52888 | 9.605192 |
| emp_absence | -8.588916 | 7.981191 | -1.08 | 0.285 | -24.43358 | 7.255751 |
| local_supp~r | -2.878159 | 6.178359 | -0.47 | 0.642 | -15.14375 | 9.387435 |
| supply_iss~s | 11.1325 | 6.63127 | 1.68 | 0.096 | -2.032239 | 24.29723 |
| essential | 14.85621 | 6.984186 | 2.13 | 0.036 | .9908517 | 28.72158 |
| opp_zone | 5.856124 | 8.811199 | 0.66 | 0.508 | -11.63632 | 23.34857 |
| _cons | -11.59997 | 17.54879 | -0.66 | 0.510 | -46.43871 | 23.23878 |

*Table 4:*

```
. test retail = restaurant = prof_service = educ_wellness = manufacturing

 ( 1)  retail - restaurant = 0
 ( 2)  retail - prof_service = 0
 ( 3)  retail - educ_wellness = 0
 ( 4)  retail - manufacturing = 0

       F(  4,   109) =    5.48
            Prob > F =    0.0005
```

*Table 5:*

```
. reg revenue_change minority_owned women_owned yrs_open expand_prior hours_aff
> ected _employees emp_layoffs local_customer emp_absence supply_issues opp_zon
> e essential
```

| Source | SS | df | MS | Number of obs | = | 114 |
|---|---|---|---|---|---|---|
| | | | | F(12, 101) | = | 2.90 |
| Model | 34061.6203 | 12 | 2838.46836 | Prob > F | = | 0.0018 |
| Residual | 98964.0376 | 101 | 979.841957 | R-squared | = | 0.2561 |
| | | | | Adj R-squared | = | 0.1677 |
| Total | 133025.658 | 113 | 1177.21821 | Root MSE | = | 31.302 |

| revenue_ch~e | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| minority_o~d | -5.78916 | 9.383353 | -0.62 | 0.539 | -24.40321 | 12.82489 |
| women_owned | -11.66959 | 7.686724 | -1.52 | 0.132 | -26.91799 | 3.578799 |
| yrs_open | .5661051 | .3668884 | 1.54 | 0.126 | -.1617029 | 1.293913 |
| expand_prior | -.3528405 | 6.286536 | -0.06 | 0.955 | -12.82364 | 12.11796 |
| hours_affe~d | -17.67705 | 6.574454 | -2.69 | 0.008 | -30.719 | -4.635098 |
| _employees | -.0829192 | .0474296 | -1.75 | 0.083 | -.1770067 | .0111684 |
| emp_layoffs | -.1574982 | .0814095 | -1.93 | 0.056 | -.3189928 | .0039964 |
| local_cust~r | -8.855865 | 6.59225 | -1.34 | 0.182 | -21.93312 | 4.221386 |
| emp_absence | -9.269038 | 7.993075 | -1.16 | 0.249 | -25.12515 | 6.587073 |
| supply_iss~s | 8.699274 | 6.255601 | 1.39 | 0.167 | -3.710154 | 21.1087 |
| opp_zone | 6.812058 | 8.790736 | 0.77 | 0.440 | -10.6264 | 24.25051 |
| essential | 11.44368 | 6.341196 | 1.80 | 0.074 | -1.135549 | 24.0229 |
| _cons | -26.49172 | 10.70581 | -2.47 | 0.015 | -47.72916 | -5.25428 |

*Table 6:*

```
. reg revenue_change retail restaurant prof_service educ_wellness manufacturing
>  yrs_open hours_affected _employees supply_issues essential
```

| Source | SS | df | MS | Number of obs | = | 115 |
|---|---|---|---|---|---|---|
| | | | | F(10, 104) | = | 5.14 |
| Model | 45559.7674 | 10 | 4555.97674 | Prob > F | = | 0.0000 |
| Residual | 92232.4065 | 104 | 886.850062 | R-squared | = | 0.3306 |
| | | | | Adj R-squared | = | 0.2663 |
| Total | 137792.174 | 114 | 1208.70328 | Root MSE | = | 29.78 |

| revenue_ch~e | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| retail | -17.52431 | 12.30219 | -1.42 | 0.157 | -41.92002 | 6.871398 |
| restaurant | -44.1816 | 13.83405 | -3.19 | 0.002 | -71.61503 | -16.74817 |
| prof_service | -4.124518 | 12.02195 | -0.34 | 0.732 | -27.96449 | 19.71545 |
| educ_welln~s | -28.92066 | 13.79665 | -2.10 | 0.038 | -56.27993 | -1.561381 |
| manufactur~g | -1.226824 | 14.08775 | -0.09 | 0.931 | -29.16336 | 26.70971 |
| yrs_open | .4484325 | .3354574 | 1.34 | 0.184 | -.2167921 | 1.113657 |
| hours_affe~d | -12.97042 | 6.303362 | -2.06 | 0.042 | -25.47022 | -.4706138 |
| _employees | -.1029468 | .0451267 | -2.28 | 0.025 | -.1924348 | -.0134589 |
| supply_iss~s | 11.0218 | 6.402051 | 1.72 | 0.088 | -1.673706 | 23.71731 |
| essential | 15.3626 | 6.322887 | 2.43 | 0.017 | 2.824074 | 27.90112 |
| _cons | -24.71112 | 13.86035 | -1.78 | 0.078 | -52.19671 | 2.774463 |

*Table 7:*

```
. tabstat revenue_change, statistics(variance, sd)

    variable |  variance        sd
-------------+--------------------
revenue_ch~e |  1208.703  34.76641
```