The Impact of the COVID-19 Pandemic on Framingham Businesses

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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 he

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

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 &

(1) = 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

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

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

$$(1)\ Y = {}_1(retail) + {}_2(restaurant) + {}_3(prof\_service) + {}_4(educ\_wellness) + {}_5(manufacturing) + {}_6(minority\_owned) + {}_7(women\_owned) + {}_8(yrs\_open) + {}_9(expand\_prior) + {}_{10}(hours\_affected) + {}_{11}(\_employees) + {}_{12}(emp\_layoffs) + {}_{13}(local\_customer) + {}_{14}(emp\_absence) + {}_{15}(local\_supplier) + {}_{16}(supply\_issues) + {}_{17}(essential) + {}_{18}(opp\_zone)$$

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 statist

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

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, with a mean dev

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

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

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Figure 1:

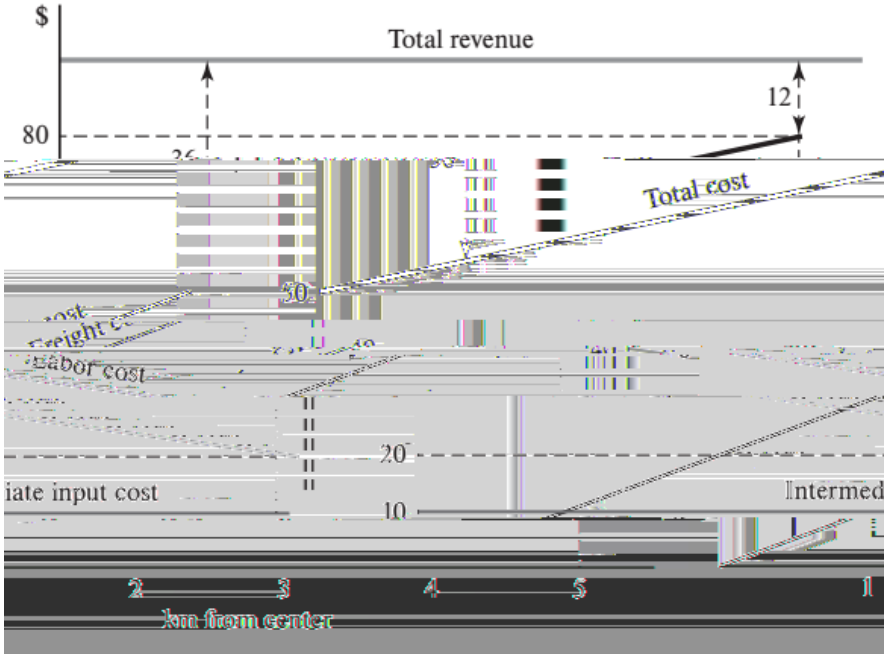


Figure 2:

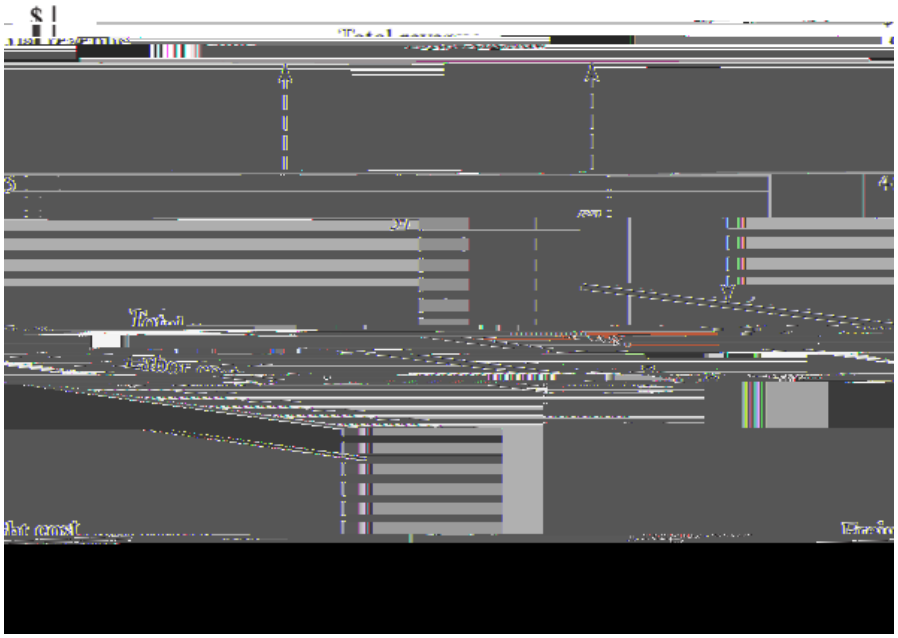


Figure 3:

Figure 4:

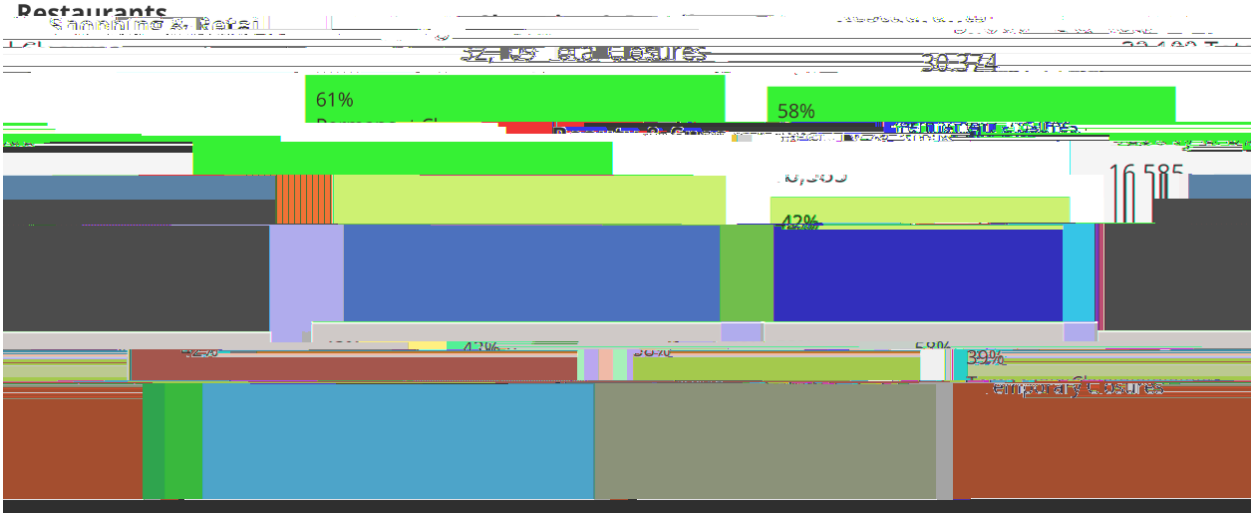
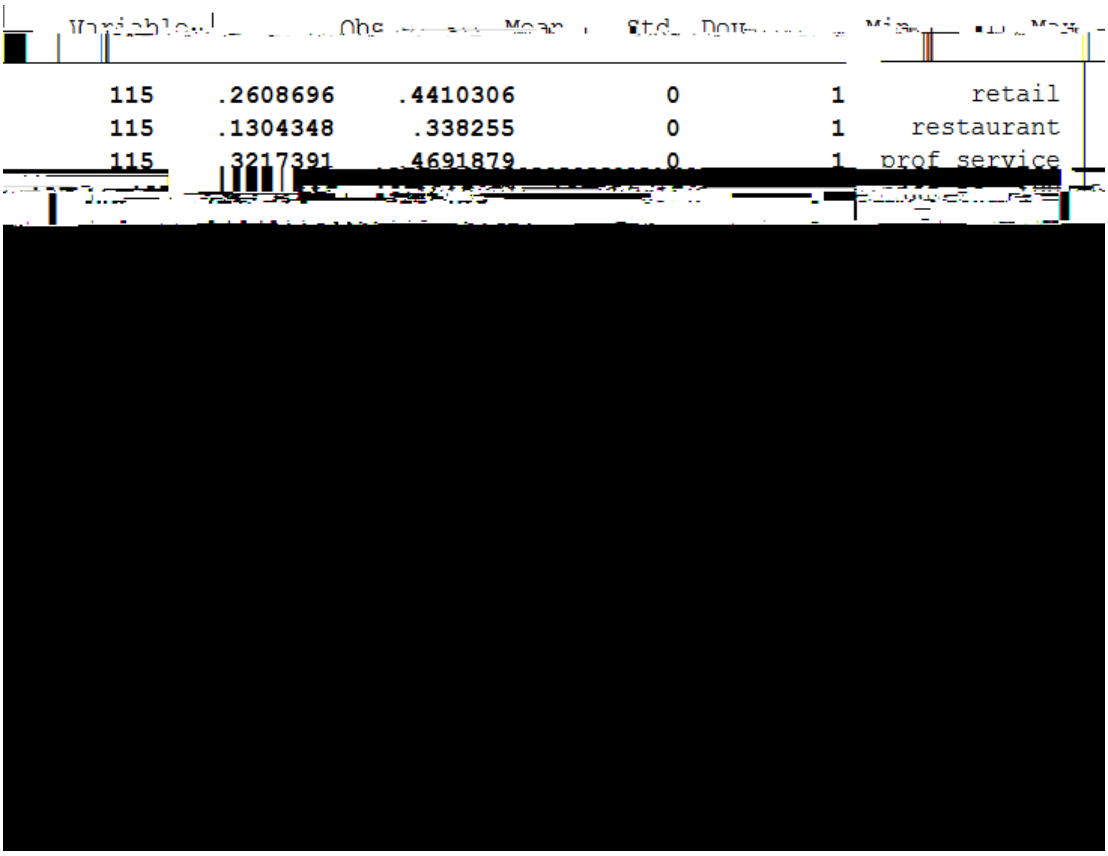


Table 1:

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)

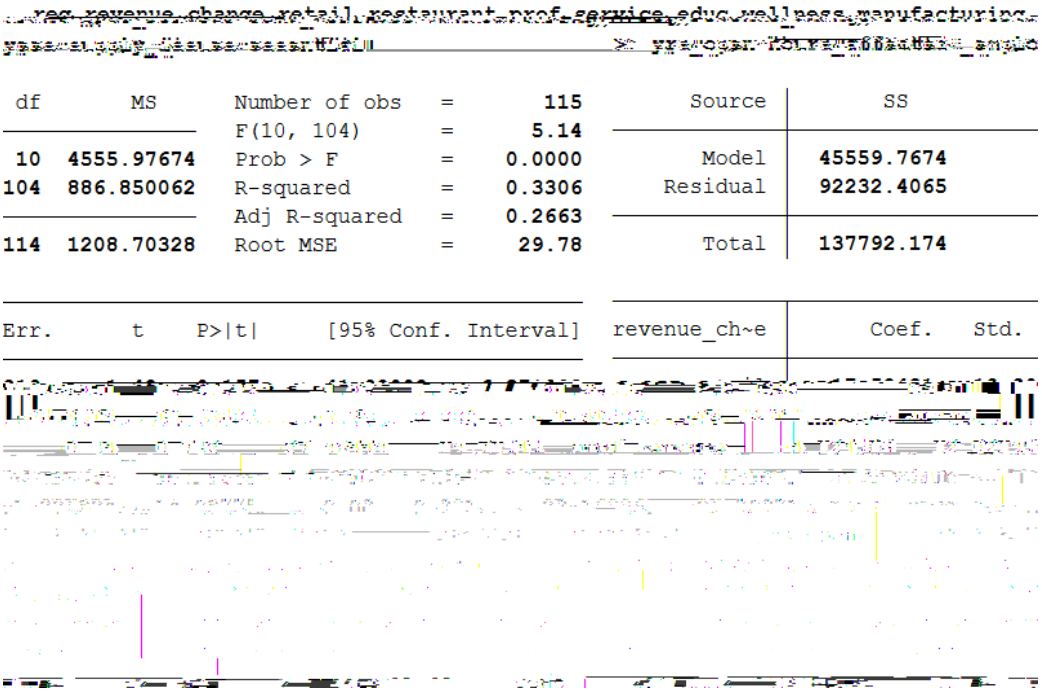
Table 2:



Variable	Obs	Mean	Std. Dev.	Min	Max	
	115	.2608696	.4410306	0	1	retail
	115	.1304348	.338255	0	1	restaurant
	115	.3217391	.4691879	0	1	prof service

Table 5:

Table 6:



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

Err.	t	P>|t|	[95% Conf. Interval]	revenue_ch~e	Coef.	Std.

Table 7: