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Table of Contents

Impacts of Environmental Tariffs on NYS

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ABSTRACT

In June of 2017 President Donald Trump announced plans to withdraw the United States from the Paris Agreement, a global response to the threat of climate change. The withdraw of the US undoubtably will impede global progress in keeping global temperature rise below 2 degrees Celsius as it is the second largest emitter of carbon dioxide in the world. The withdraw voids the pledges the US has made to reduce emissions, giving domestic firms an unfair advantage in the global market. In response the European Commission has outlined in its Green Deal policy proposal the implementation of a carbon border adjustment mechanism to ensure that the price of imports accurately reflects carbon content. If the US is subject to this policy it could have significant impacts on the country's export sector. This paper preliminarily examines data to formulate a discussion about the potential impacts of a carbon border adjustment mechanism by the European Union specifically on New York State.

1. INTRODUCTION

On June 1, 2017 President Donald Trump announced his plans to withdraw the US from the Paris Agreement. The Paris Agreement, an international nonbinding climate change agreement was signed on April 22, 2016 and went into effect on November 4, 2016. The Agreement has aims of preventing global temperatures from rising above the 2-degree Celsius threshold, of helping countries and economies adapt to a changing climate, and of offering aid to less developed economies in the transition. As the second largest emitter of CO2 in the world, the withdraw of the US will have far reaching impacts, especially given that the US had pledged an economy-wide target of reducing greenhouse gas (GHG) emissions by 26-28% below 2005 levels by 2025. As the second largest emitter of carbon dioxide worldwide these pledged decreases in emissions were highly significant. The withdraw will additionally place a financial burden on remaining countries to the agreement both in aiding less developed economies transition to clean energy and also in aiding the most vulnerable countries recover from disasters linked to climate change.

As the US is taking a step back, other countries are moving forward in their environmental ambitions. China, for instance, the largest emitter of carbon dioxide, has pledged to reach peak emissions by 2030 and also to reduce its use of fossil fuels to 20% of its total energy supply by 2030. The EU, a world leader in combating climate change, has pledged to reduce greenhouse gas emissions by at least 40% by 2030 from 1990 levels. Additionally, India has announced its goal of reducing emissions intensity of GDP by 33-35% from 2005 levels by 2030.

The US's withdraw from the agreement can give an unfair advantage to US firms via lower costs and less regulatory hurdles. Subsequently, this can also be viewed as a disadvantage to other countries who are participating in the agreement. In July 2019 Ursula von der Leyen was confirmed as the next president of the European Commission. She will succeed the current president Jean-Claude Juncker and officially take office on November 1, 2019. Her proposed policy agenda lists several goals for the EU to accomplish including climate objectives like the EU's version of the Green New Deal which she pledged to implement within her first 100 days in office. This proposal, the Green Deal, includes a resolution to enter into law the

deadline that the EU become carbon neutral by 2050. In order to meet this ambitious target, she states, "Every person and every sector will have to contribute". Her plan includes extending the EU Emissions Trading System (ETS) .and the introduction of a Carbon Border Tax (CBA). She notes that this is needed in order to prevent carbon leakage and to help ensure a level playing field for European companies. Until now, most of the suggestions around CBA's have been dismissed by governments and lobby groups as many anticipate they would violate WTO rules. Immediately it is apparent that an allowance of these measures could promote a protectionist agenda under the guise of climate policy. Although cautions still exist, Europe's biggest lobby group has opened discussions about a possibility of a carbon tariff. The president of France, Emmanuel Macron has also voiced his support of such policies for those that do not sign on to the Paris Agreement.

The implementation of a CBA by the EU will impact the US, and more specifically, New York State (NYS). This paper gives a preliminary look into how NYS exports are linked to the EU and sets the ground for future research examining how NYS may be affected by such a policy measure. The remainder of the paper is organized as follows: section 2 gives a brief overview of carbon border adjustments, section 3 details NYS's exports to the EU and section 4 concludes.

2. CARBON BORDER ADJUSTMENTS

The justification for carbon border tax adjustments come not only from the desire to keep a competitive environment but also from carbon leakage theory. This theory posits that when a few countries ambitiously reduce emissions, the reduction can be offset by other economies increasing their emissions partially through the physical relocation of these industries or with shifting cost advantages to firms in these polluting economies. Other than a tax on the carbon content of imports entering the emission reducing country, policy proposals which are considered carbon border adjustments also include the requirement of importers to surrender carbon permits or even a rebate tax on exports.

WTO rules require that border carbon adjustments do not discriminate among trade partners by singling out specific countries. The charge must be based on the carbon content of products. The adjustment should reflect the difference in carbon constraints between the imposing and targeted economies. As Mehling et. al (2018) discuss, a CBA policy should take into consideration several key components, which I summarize in this paragraph. First, there should be no rebates of the carbon costs to exporters. This policy could create a perverse incentive for producers to increase the carbon intensity of exports hence undermining the environmental benefits of the measure. Second, the policy measure should be limited to primary goods. Country-level data for these commodities is increasingly available, and the calculation of their carbon footprint is easier than for composite goods. Third, the design and implementation of a CBA should take place through a deliberate process which can ensures fairness, transparency and predictability. This will help in making a CBA more politically acceptable to trade partners and additionally increase the odds of the measure passing legal muster. Lastly, border carbon adjustments should become obsolete once producers are able to reduce their carbon content in production.

Under the most favored nation (MFN) clause setting tariffs at different rates for members is a violation. There is an exception when it comes to the conservation of natural resources. If the environment can be categorized into that we have yet to see.

3. POTENTIAL EFFECTS ON NYS

For the purpose of this paper we assume that aluminum, cement and steel are likely to be the targeted goods for a CBA policy. As such, we primarily focus on data related to these commodities. The USA trade data was gathered from the Census Bureau and the Office of the United States trade Representative.

In 2018 New York State exported $81.5 billion which ranks it as the third largest state exporter in the US. In this same year $20 billion was exported to the EU, nearly 25% of the value of all state exports. Of these exports, manufacturing products accounted for $63.1 billion with the largest manufacturing export category being miscellaneous manufactured commodities ($23.1 billion) and other top manufacturing exports being primary metal manufacturing ($8.2 billion), computer & electronic products ($7.4 billion), machinery, except electrical ($5.3 billion), and chemicals ($5.3 billion). In 2016 an estimated 295,000 jobs were supported by the export industry, a figure the Office of the US Trade Representative estimated to be 18% above the national average. A total of 36,739 companies exported from New York locations in the same year, of which 34,413 (94 percent) were small and medium sized enterprises (SME) with fewer than 500 employees. Small and medium-sized businesses accounted for 55.1 percent of New York's total exports of goods in 2016.

In order to examine data by metropolitan area we use data from 2017 as this is the latest available year. In 2017 NYS recorded exports of $93.7 billion, of which Buffalo had $5 billion, Rochester $4.7 billion, Albany $3.9 billion, Syracuse $2.1 billion, Utica $558.9 million, Binghamton $394.6 million, Ithaca $312.3 million, Glens Falls $246.5 million, Kingston $196.9 million, Watertown-Fort Drum $164.5 million, and Elmira $150.8 million. These numbers show that Western New York also may be significantly impacted by the imposition of a CBA due to the volume of exports coming from Buffalo and Rochester, and to a smaller extent, Elmira.

Examining commodity prices of aluminum, steel and cement from FRED, and tariff data from the WTO for the years 2002 – 2017 we see there is a strong correlation between the price of aluminum and NYS exports of aluminum to the EU, the price of steel and NYS exports of steel to the EU, while the correlation between price of cement and NYS exports of cement to the EU is quite weak. If the export price of aluminum and steel is increased by a CBA this could potentially harm business for NYS and WNY significantly. Given that many of these firms are SME’s it is likely that the hardship would be greater than if a large corporation was facing the same circumstances. In terms of local jobs this could place even more of a burden on already struggling manufacturing industries.

4. CONCLUSION

NYS exports a significant potion of its total exports to the European Union, nearly 25%. Of the businesses that do export, 94% of them are SME's. As the likelihood of a CBA being imposed by the EU becomes more likely, an examination into the potential impact on NYS is warranted. A preliminary look at data shows that NYS's export sector is likely to be significantly impacted, even if the CBA is placed only on primary goods like steel, aluminum and cement.

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The Relationship between Local Air Quality and Officiating Quality in the National Football League

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ABSTRACT

Air pollution affects health and labor productivity. This paper examines the impact air pollution has on referee productivity during games played from the 2019 National Football League season. At game time, we record air quality, officiating performance, and other controls with which to estimate a nonlinear model. We find evidence that an increasing presence of ozone and particulate matter 2.5 parts per million results in fewer challenges, fewer challenges per penalty, and a lower ratio for challenges which result in an overturned officiating call. The results encourage further examination for team challenge strategy as well as additional data collection.

INTRODUCTION

Air pollution impacts human health. Previous studies have examined the effects of air quality on worker productivity, individual productivity, factory productivity, and athletic productivity. In this paper, we examine the effect local air pollution has on officiating quality for National Football League (NFL) games. Officials monitor and enforce the rules of the game, and if their performance is affected by air quality, their mistakes may affect game outcomes. Spectator interest may decrease if they expect that game officials will make more errors in their calls and this in turn may lead to lower attendance and smaller values of the media rights. Studies for the effects of varying air quality levels on humans increase the knowledgebase for options to appropriately regulate air quality.

Pollution measurement is standardized by The Air Quality Index (AQI). AirNow describes the AQI as a measure on a scale between 0 and 500, the six main pollutants: ozone, particulate matter 2.5 which measures particles in the air that are 2.5 microns in width or less (PM2.5), particulate matter 10 which measures particles in the air that are 10 microns in width or less (PM10), sulfur dioxide, nitrogen dioxide, and carbon monoxide. AQI is separated into six segments representing how clean or polluted is the air. These segments are correlated with the health effects individuals may experience due to the measured levels of pollution. For instance, a “Good” measure for AQI is between 0 and 50 and means, “Air quality is considered satisfactory, and air pollution poses little or no risk.” At the opposite end of the range, a measure

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between 300 and 500 AQI is labelled “Hazardous,” which means, “Health warnings of emergency conditions. The entire population is more likely to be affected.”

AirNow reports that ground level ozone and airborne particulate matter are the primary pollutants which affect human health in the United States. Ozone is a colorless gas found in the air and separated into two types, good ozone and bad ozone. Good ozone is naturally occurring in the atmosphere between 10 and 30 miles above the Earth’s surface. It shields us from harmful ultraviolet rays that radiate from the sun. Bad ozone is present at ground level when air pollutants produced by cars, chemical plants and power plants chemically react to sunlight. Ground level ozone affects human health in many ways, including respiratory irritation, lung function reduction, and inflammation and damage to cells lining the lungs. These symptoms result in increased susceptibility for lung infections and can further harm individuals with existing lung diseases. Particulate matter pollution is a mixture of microscopic liquids and solids which are present in the air. These pollutants include acids (nitrates and sulfates), organic chemicals, metals, soil, dust, and allergens. PM10 is viewed as most dangerous and directly correlated with health problems. These particulates may be inhaled deep into the lungs and harm the lungs and heart. PM2.5 consists mostly of smoke and haze and PM10 consists mainly of dust.

The AQI is correlated with impacts for human health, where high scores for AQI is associated with lower quality health outcomes. Health is a factor for labor productivity. Poor air quality has been shown to have negative impacts for labor productivity. On average, healthier individuals can afford higher standards of living. Air quality effects on human health in turn influences policymakers to take actions which have an objective to decrease air pollution.

Short-term efforts are temporary. Efforts to improve air quality through regulation must be sustained to maintain gains. Sport can be a justification policy makers use to regulate human activity and production to reduce air pollution. In preparation for the 2008 Olympics in Beijing, the city government implemented a series of policies to improve the air quality. Zhang et al. (2016) evaluate whether these regulations improved the quantitative amount of air quality from 2001 to 2012. Using surrounding cities as control groups, they estimate Beijing’s air quality improvement using a Synthetic Control Method and compare the difference in air quality in Beijing before and after the Olympics. They show that air quality improved between 2008 and 2010. After 2010, environmental policies diminished, and air quality worsened to the higher pre-Olympic levels. They conclude the Olympics had no long-term effect on air quality in Beijing.

Sporting events also contribute to local air pollution. Locke (2019) studies the impact by Major League Baseball (MLB) games attendance on local air quality. For each game between 2010 and 2016, Locke collects air quality data recorded of ozone, sulfur dioxide, nitrogen dioxide, carbon monoxide, PM2.5, and PM10 from the EPA’s AirNow database between 2010 and 2016. Locke finds that ozone and attendance are positively correlated, but the absolute effect is not large enough to cause a public health concern.

The evidence consistently shows air pollution has a negative impact on the short-term worker productivity. Graff Zivin & Neidell (2012) examine the relationship between individual-level daily harvest rates for agricultural workers and air quality in California. They find an increase of 10-parts per billion in

ozone levels leads to a short-run productivity decrease of 5.5 percent. Their results are evidence that increases in air pollutants have a negative impact for the short-term productivity by low-skilled workers. These effects are also observed inside. Chang et al. (2016) study the impact of outdoor air quality on the productivity of workers at an indoor pear-packing factory between 2001 and 2003. While there is little impact from ozone, increasing levels of PM2.5, which can travel indoors, have a significant and nonlinear negative affect on worker productivity. Athletes, like workers who pack pears, have physically demanding employment and may find their indoor performance harmed by outside levels of PM2.5.

For those who perform desk work, evidence shows outdoor air pollution reduces the cognitive function of indoor workers. Chang et al. (2019) find that indoor call center workers in China are less productive with increases in air pollution, and a 10-unit increase in the air pollution index results in an estimated decrease in daily calls of 0.35 percent. Kahn and Li (2020) estimate that a 1 percent increase in PM2.5 increases case handling time by 0.182 percent by judges in China. On high air pollution days, these judges are more likely to make decisions on complex cases that are appealed and over-ruled.

In sports, studies exist for air quality and individual athletic performance in various sports, such as soccer, marathon running, and umpires in MLB. Chang et al. (2016, 2019) and Graff Zivin and Neidell (2012) offer evidence that workers whose work is both physical and cognitive are likely to be less productive due to higher levels of air pollution. The harm to productivity from air pollution occurs whether the worker is outdoors or indoors. Game officials have demanding physical and cognitive work when evaluating play to make their calls. Their work may occur either indoors or outdoors depending upon the sport and stadium setup. Where air quality affects sporting event officiating quality, we hypothesize air pollution is positively correlated with gametime referee officiating error. Knowing the effects of air pollution on game outcomes will better inform sport executives and managers for how to improve athletic performance and sporting event officiating quality. Fewer officiating errors will increase spectator confidence in the game results, maintain attendance, and enhance the value of media rights.

We proceed as follows. In the next section, we review literature as it pertains to studies for the relationship between air pollution and athletic performance. We then describe our data, explain our model, show and interpret our results, and conclude with a discussion.

LITERATURE REVIEW

The sports studies literature offers several papers which provide the effects of air pollution on athletic performance and officiating. Air pollution, in particular nitrogen dioxide and ozone, has a negative impact on outdoor exercisers. Particulate matter is a matter of concern (Carlisle and Sharp, 2001).

Air pollution affects athletic performance. For instance, Guo & Fu (2019) examine the relationship between the finish time of domestic marathon runners in China and air quality, including the pollutants PM2.5, PM10, sulfur dioxide, nitrogen dioxide, carbon monoxide, and ozone. Their results show that a top marathon runner requires an additional 4.8 minutes to finish a race in the 2014 Beijing Marathon, where the air was severely polluted, compared to running a race with the average air quality in China.

Greater levels of ozone have been observed to have harmful effects for athletic performance. Mullins (2017) studies the effects of ozone exposure on the performance of collegiate track and field athletes. Athletics are estimated to suffer a performance decrease of 0.39 percent due to an additional increase in ozone of 10 parts per billion.

More particulate matter, too, decreases athletic performance. Lichter et al. (2017) study the effect of ambient air pollution on the productivity of professional soccer players in Germany between 1999 and 2011. They record the hourly concentration of ozone and PM10 in the proximity of the stadium from the time of kick-off until the match concludes. They find moderate levels of PM10 have a negative and non-linear effect on short-run productivity and estimate that a 1 percent increase in PM10 results in 0.02 percent decrease in the number of ball passes.

Sport cognitive function is also affected by air pollution. Archsmith et al. (2018) study how short-term exposure to air pollution affects work performance of officials, a group of highly skilled, quality-focused employees. They observe changes in air quality impact the accuracy of the umpire's calls for "ball" and "strike." MLB uses the Supervisor Umpire Review and Evaluation System to track umpire performance. PITCHf/x provides a measure of balls and strikes against which an umpire's decision making can be compared. Using pitch data from MLB games between 2008 and 2015 and environmental data collected from the Environmental Protection Agency's Air Quality System, Archsmith et al. find exposure to elevated carbon monoxide and PM2.5 reduces the umpire's call accuracy. Specifically, as carbon monoxide increases by 1 part per million in 3-hours, an umpire performs an additional 2.0 incorrect calls per 100 decisions. Also, an increase of 10 micrograms per cubic meter of air in 12-hour PM2.5 results in an estimated additional 0.4 incorrect calls per 100 decisions.

These studies all contribute to the growing literature which provides evidence air pollution has a negative effect for productivity by individual athletes and game officials. In this paper, we study the effects of air quality for NFL referee calls during the 2019 season. NFL referees work indoors and outdoors, exert themselves to observe player actions during play, and must cognitively interpret their observations and the rules of play to make judgements.

DATA

We use game-to-game data from the 2019 season of the NFL to test the relationship between air quality and officiating quality. The air quality data, collected for ozone and PM2.5, PM10, and sulfur dioxide, are recorded in AirNow.gov and the Air Quality Index Daily Values Report from the Environmental Protection Agency website and their *Air Quality Index Daily Values Report*. We match our air quality data to the date and city the NFL games were played.

Our NFL game-level data are obtained from ProFootballReference.com. We use three officiating quality measures: *Challenges*, *ChallengesPerPenalty*, and the *RatioOfOverturnedChallenges*. *Challenges* is the total number of challenges per game. *ChallengesPerPenalty* is the number of penalties challenged. The

RatioOfOverturnedChallenges is the ratio of the number of overturned referee calls to the number of challenges.

The playing rules for 2019 allowed each team two challenges. To challenge the call of a play, the Head Coach is required to throw a red flag into the field prior to the next snap or kick. A call may be challenged when the team has an available timeout, because if upon review of the play the game officials uphold the initial call, the team that challenged the call losses a timeout. The Head Coach can challenge only on-field rulings.[1] A team that initiates a challenge when not permitted losses a timeout, and if the team has no timeouts remaining, a foul of 15 yards is enforced. If a team is successful on both of its challenges, it is awarded another timeout (National Football League, 2019, pp. 61-64).

We also collect game-level variables that can impact officiating, measured by *AbsDiffScore*, *TotalTurnovers*, *TotalPenalties*, and *TotalPenaltyYards*. *AbsDiffScore* is the absolute difference in the score between the two teams in a game. *TotalTurnovers* are the number of turnovers between both teams in a game. *TotalPenalties* represents the total number of penalties in a game level. *TotalPenaltyYards* represents the total number of penalty yards in a game.

Table 1 shows the summary statistics. The AQI can be categorized into six levels from “Good” to “Hazardous.” A “Good” AQI level ranges from 0-50, where air pollution poses little to no risk. A “Moderate” AQI level ranges from 51-100, where the air quality is acceptable, although a small number of individuals may be affected due to a high level of sensitivity. An AQI range of 101-150 is considered “Unhealthy for Sensitive Groups,” where sensitive groups will most likely experience health effects, but the general public would not likely be affected. An AQI level between 151-200 is considered “Unhealthy,” and everyone may experience health effects. AQI levels between 201-300 are considered “Very Unhealthy,” while a range between 301-500 is considered “Hazardous” (AirNow).

Our game-level air quality measures report “Good” to “Unhealthy for Sensitive Groups” for the AQI levels of ozone and PM2.5. On average, the AQI level of ozone is 35.7, with a maximum of 101. For PM2.5, the average AQI level is 41.4, with a maximum of 124. On the other hand, PM10 and sulfur dioxide have AQI measures for their range between “Good” and “Moderate.” The average value for PM10 is 20.28, which is “Good” air quality, and its range is between 6 and 68. Sulfur dioxide has an average value of 4.59, “Good” air quality, and a range between 0 and 70.

Table 1. Summary Statistics

	Obs.	Mean	Std. Dev.	Min	Max
Challenges	256	0.844	0.849	0	4
Challenges per Penalties	256	0.070	0.088	0	0.75
Ratio of Overturned Challenges	151	0.359	0.427	0	1
Ozone	228	35.72	15.68	5	101
Particulate Matter 2.5	241	41.44	17.55	7	124
Particulate Matter 10	104	20.28	11.11	6	68
Sulfur Dioxide	197	4.59	9.25	0	70
Total Penalty Yards	256	114.48	38.16	30	236
Total Penalty	256	13.48	3.91	4	25
Absolute Difference in Score	256	11.64	9.18	0	49

In Table 1, the average number of challenges per game is 0.8, and 7 percent of penalties are challenged. From the number of penalties challenged, approximately 36 percent of the referee's calls are overturned. That is, from the contested referee calls, the referees make an incorrect decision roughly one-third of the time. There are, on average, 13.5 penalties per game, 114.5 total penalty yards per game, and an average of 11.6 difference in points between the winning and losing team per game.

EMPIRICAL MODEL AND RESULTS

This study uses an ordinary least squares (OLS) regression model to estimate the effect of air quality on officiating quality. The model follows as:

$$Officiating\ Quality_i = \beta_0 + \beta_1 AQI_i + \beta_2 AQI_i^2 + \beta_X' X_i + u_i$$

where i represents the game played. We identify $Officiating\ Quality_i$ in three forms: *Challenges*, *ChallengesPerPenalty*, and the *RatioOfOverturnedChallenges*.

AQI_i represents the respective AQI levels of either ozone, PM2.5, PM10 or sulfur dioxide. AQI_i is squared in the model to identify whether the relationship between the air quality AQI_i and $Officiating\ Quality_i$ are nonlinear. We expect larger in amount measures of air pollutants will result in an expected increase of *Challenges*, *ChallengesPerPenalty*, and the *RatioOfOverturnedChallenges*.

X_i is a vector of control variables specific to the *Challenges*, *ChallengesPerPenalty*, and the *RatioOfOverturnedChallenges* equations. Our control variables are *AbsDiffScore*, *TotalTurnovers*, *TotalPenalties*, and *TotalPenaltyYards*. The closer the score, we expect a challenge to be more likely. A more competitive game may result in players playing more aggressively, leaving the referee to make difficult decisions. The total number of turnovers may signify the competitiveness of the game and crucial refereeing decisions. The total number of penalties and penalty yards signify the number of times the referee makes a decision, which may lead to cognitive decline and a decision subject to challenge.

Table 2 presents the result for the relationship between the AQI level of ozone and officiating quality. Our model estimates for AQI levels of PM10 and sulfur dioxide are not significant and not shown here. *TotalPenalties* is excluded in the *ChallengesPerPenalty* and *RatioOfOverturnedChallenges* equations because of multicollinearity. *TotalPenaltyYards* is excluded in the *Challenges* and *ChallengesPerPenalties* equations for the same reason.[2.] Each of the estimated specifications is statistically significant. We find that a one unit increase in the AQI level of ozone results in a 0.027 decrease in the total number of challenges. The relationship is weakly significant, and there is no evidence of nonlinearity. That is, at higher observed AQI level of ozone, we do not observe higher AQI level of ozone result in more challenges. For challenges per penalty, we find a nonlinear relationship. At around 62.1 AQI level of ozone, an additional unit increase in the AQI level of ozone results in more challenges per penalty. We observe a nonlinear relationship between the AQI level of ozone and the ratio of overturned challenges, where at around 41.7 AQI level of ozone, a one unit increase in AQI level of ozone results in an increase in the ratio of overturned challenges.

Table 2: Ozone

	(1) Challenges	(2) Challenges per Penalty	(3) Ratio of Overturned Challenges
Ozone	-0.0271*	-0.00435***	-0.0168*
	(0.0142)	(0.00146)	(0.00864)
$Ozone^2$	0.000221	0.000035**	0.000202**
	(0.000140)	(0.000014)	(0.000083)
Absolute Difference in Score	-0.0103*	-0.000495	-0.00162
	(0.00618)	(0.000629)	(0.00449)
Total Penalties	-0.00221		
	(0.0157)		
Total Turnovers	0.0616*	0.00490	0.0118
	(0.0319)	(0.00327)	(0.0213)
Total Penalty Yards			-0.00125
			(0.00101)
Constant	1.478***	0.154***	0.670**
	(0.464)	(0.0413)	(0.280)
Observations	228	228	135
R-squared	0.147	0.162	0.218

Standard errors in parentheses; *** significant at 1% level, ** significant at 5% level, * significant at 10% level

Table 3: Particulate Matter Less Than 2.5 Microns in Width

	(1) Challenges	(2) Challenges per Penalty	(3) Ratio of Overturned Challenges
Particulate Matter 2.5	-0.0201*	-0.00210*	-0.00471
	(0.0111)	(0.00117)	(0.00664)
Particulate Matter 2.5^2	0.000152	0.000019*	0.000090
	(0.000112)	(0.000011)	(0.000065)
Absolute Difference in Score	-0.00791	-0.000268	0.000976
	(0.00610)	(0.000642)	(0.00439)
Total Penalties	0.00427		
	(0.0149)		
Total Turnovers	0.0519*	0.00459	0.0283
	(0.0306)	(0.00323)	(0.0215)
Total Penalty Yards			-0.000801
			(0.000999)
Constant	1.258***	0.0968***	0.355
	(0.410)	(0.0368)	(0.247)
Observations	241	241	140
R-squared	0.136	0.110	0.185

Standard errors in parentheses; *** significant at 1% level, ** significant at 5% level, * significant at 10% level

Table 3 shows a nonlinear relationship between the AQI level of PM2.5 and challenges per penalty. At around 55.3 PM2.5, a one unit increase of the PM2.5 increases the number of challenges per penalty. The affect is weakly significant.

Although we find evidence that air quality affects officiating quality, the effects in magnitude are relatively small. This may be because none of the games was played at “Unhealthy” AQI levels. However, our results provide evidence that the ozone level has an important role in NFL officiating quality. As noted above, the estimated models for PM10 and sulfur dioxide are not significant We believe this is due to a lack of variation in the AQI levels for both pollutants.

DISCUSSION AND CONCLUSION

The estimated models share much in common with prior papers. Our estimated models are non-linear. Like Mullins (2018), we find ozone to have significant effects on officiating quality. Like Chang et al. (2016) and Kahn and Li (2020), we find PM2.5 to have significant effects, although weakly significant, on officiating quality.

We are surprised our results show that higher levels of ozone result in fewer challenges, fewer challenges per penalty, and a smaller ratio of overturned challenges. The decision by coaches to challenge a referee’s call is more complicated than we have modelled. Play occurs, referees observe and evaluate, make calls, some of which are subject to a possible challenge. Coaches have a short amount of time to challenge a call and must evaluate the referee’s call in the same environment of the referee. The team coaches and referees are exposed to the same air quality. In a note by analysts in NFL Football Operations (2019), through week 10 of the season, 13 of 32 head coaches had yet to win a challenge.

Given that each team has a limited number of challenges subject to other limitations, coaches must develop a strategy for challenging. We have not attempted to model the game, or the strategies teams and their coaches apply to challenge a referee’s call.

Alternatively, it could be that the referees make good calls, and the pollution affects the coaching staff’s evaluation of the officials’ calls. From our results, we could infer that as air pollution worsens, head coaches choose to challenge calls less. For those challenges made by Head Coaches as air pollution increases, they incorrectly evaluate the calls following a review of the play.

This study expands on previous literature to test the relationship between the AQI and individual productivity. We estimate the impact of the AQI levels for ozone, PM2.5, PM10 and sulfur dioxide on productivity and officiating quality in the NFL. We find that ozone has a small but significant impact on officiating quality, and PM2.5 has a weakly significant impact.

ENDNOTES

1. Section 3 of the playing rules outlines the rulings the Head Coach may challenge and Section 4 lists non-reviewable plays (National Football League, 2019, pp. 61-64).

2. We also control for the week each game was played. We do not report their coefficients.

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Employment in Cuba after the Labor Market Reforms of 2010

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ABSTRACT

The new socioeconomic reality in Cuba, is taking shape through the cumulative introduction of economic reform measures, the most important of which include large state worker layoffs, and the expansion of the private sector in the form of small businesses (Mesa-Lago, *et al.,* 2018). While official Cuban statistics do not provide a detailed breakdown of the self-employed and their firms, official statistics reveal a notable increase in the total number of self-employed workers since the introduction of labor market reforms in 2010 (González-Corzo and Justo, 2017).

INTRODUCTION

The Cuban economy can be classified as a "mixed socialist economy." Under this model (also known as market socialism), the state retains ownership of the fundamental means of production, and bureaucratic, centralized, planning remains as the principal coordinating mechanism, even though market-oriented mechanisms are allowed to operate in some sectors of the economy (Gonzalez-Corzo and Justo, 2017; Kornai, 2008). On the political front, however, the fundamental attributes of the socialist system are preserved and the Communist Party retains absolute political control and does not share its power with any other political actors (Kornai, 2008).

Starting in 2007, the Cuban government began to implement a series of transformations to "update" Cuba's socialist economic model (Spadoni, 2014; Mesa-Lago, 2018). Labor market reforms have been at the forefront of Cuba's efforts to "update" its socialist economic model. One of the most notable and lasting effects of these reforms has been the expansion of the non-state sector, particularly the growth of entrepreneurial activities, self-employment, and small and medium-sized enterprises (Bahamonde, 2018). This paper discusses the principal labor market reforms introduced in Cuba since 2010; analyzes their impact on employment in the state and non-state sectors; and proposes a series of policy measures to address the principal challenges confronted by Cuba's self-employed workers. The paper is organized as follows. Section

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1 contains this Introduction. Section 2 discusses the labor market reforms introduced in Cuba since 2010. Section 3 analyzes the impact of the reforms on employment in the state and non-state sectors using data from the National Statistics Office. Finally, section 4 presents a series of policy measures to address the principal challenges faced by Cuba's emerging self-employed workers and micro-entrepreneurs.

CUBA'S LABOR MARKET REFORMS SINCE 2010

The initial measures to transform Cuba's labor market were announced in 2010. The goal was a 20% reduction of State sector employment, resulting in the "transfer" of approximately 1 million workers to the emerging non-state sector (Ritter and Henken, 2015). These policies were formalized after the approval of the "Economic and Social Policy Guidelines of the Party and the Revolution" ("*Lineamientos de la Política Económica y Social del Partido y la Revolución"*) by the Sixth Party Congress of the Communist Party of Cuba (CPC) on April 2011 (González-Corzo and Justo, 2017).

The most important labor market reforms introduced in Cuba since 2010 include (Mesa-Lago, 2018):

- ***Increases in the number of authorized self- employment occupations*:** In 2010, the number of authorized self-employment occupations was increased from 157 (established in 2003) to 178. Three new occupations were added in 2011. The number of legally-recognized self-employment occupations was increased from 181 to 201 in 2012. However, most of these occupations (or activities) are in areas requiring low skills levels and training, resulting in the underutilization of Cuba's workforce.
- ***Authorization of direct sales by self-employed works to cooperatives and state enterprises.***
- **Hiring labor:** Self-employed workers can hire other self-employed workers as "contract employees;" those engaged in food preparation or sales can employ up to a maximum of 50 workers. The Ministry of Labor and Social Security regulates these contracts. Men over 65 years of age and women 60 or older are no longer required to be officially affiliated with a state employer, when engaging in entrepreneurial self-employment activities.
- **New tax regime:** Law No. 113 (2012) introduced a new tax regime for self-employed workers. Personal income taxes range from 15% for those earning up to 10,000 Cuban pesos (CUP) annually to 50% for those with yearly incomes in excess of 50,000 CUP. Self-employed workers are required to pay a 10% tax on sales of goods and services and a tax on the utilization of labor (i.e., when they hire other self-employed workers as independent contractors) of 5% per

year. Self-employed workers also pay 25% social security taxes on a monthly scale ranging from 350 to 2,000 pesos. The grace period for paying tax arrears (to the State) was initially extended to 10 years; however, it was revised in 2015 to introduce a shorter grade period (starting in 2017).

- ***Micro-loans from state-owned banks*:** Access to micro-loans from state-owned banks has been expanded to provide (some limited forms of) working capital for self-employed workers since 2010.

IMPACT ON STATE AND NON-STATE SECTOR EMPLOYMENT

The labor reforms introduced in Cuba since 2010 have contributed to the reallocation of labor from the state sector to the non-state sector, where wages tend to be higher (Mesa-Lago, 2018).

Table 1. Cuba: Employment in State and Non-State Sectors, *Thousands*

		State Sector		Non-State Sector					
Year	**Total Occupied Labor Force (LF)**	**State Sector**	**% of Occupied LF**	**Agri. Coops.**	**Non-Agri. Coops.**	**Self-Empl. Workers**	**Other Private**	**Total**	**% of Occupied LF**
2010	4,984.5	4,178.1	**83.82%**	217.0	0.0	147.4	442.0	806.4	**16.18%**
2013*	4,918.8	3,627.6	**73.75%**	227.0	2.3	424.3	637.8	1,291.4	**26.25%**
2018	4,482.7	3,067.0	**68.42%**	469.9	18.1	580.8	346.8	1,415.6	**31.58%**
Chg. 2010-2018	***-501.8***	***-1,111.1***	***-0.2***	***252.9***	***15.8***	***433.4***	***-95.2***	***609.2***	
% Chg. 2010-2018	***-10.07%***	***-26.59%***		***116.54%***	***686.96%***	***294.03%***	***-21.54%***	***75.55%***	

Source: Anuario Estadístico de Cuba (AEC), 2012 and 2019; authors' calculations.

As Table 1 illustrates, the state sector's share of the occupied labor force declined from 84% in 2010 to 68% in 2018. By contrast, the non-state sector's share increased from 16% to 32% during the same period. Employment in the state sector decreased by 27% between 2010 and 2018. Conversely, employment in the non-state sector rose by 76% during the same period.

Driven by higher income expectations and increased autonomy from the state, a growing number of Cubans have opted to purse self-employment. Self-employed workers (TCP) were the fastest-growing category in the non-state sector during the 2010-2018 period. These trends, particularly the notable contributions of the emerging entrepreneurial class to employment creation, are similar to those experienced by the

transition economies of Asia, Central and Eastern Europe, and the former Soviet Union (McMillan and Woodruff, 2002).

The remarkable expansion of self-employment and entrepreneurial activities has been one of the most palpable effects of the labor market reforms introduced in Cuba since 2010. Self-employed workers accounted for close to 3% of the total occupied labor force in 2010. By 2018, self-employed workers represented 13% of the total occupied labor force. The number of legally-registered self-employed workers increased by 294% during the 2010-2018 period, accounting for the bulk of employment creation in Cuba's emerging non-state sector.

CHALLENGES AND FUTURE PROSPECTS

Employment in Cuba's non-state sector has expanded significantly since the introduction of labor market reforms in 2010; however, the remarkable reallocation of labor from the state sector has been insufficient to maximize the non-state sector's potential economic contributions (González-Corzo and Justo, 2017; Mesa-Lago,2018). This has been primarily due to a series of challenges and limitations (imposed by the state), such as:

- Limits on property rights and prohibitions against the concentration of wealth and the expansion of private businesses or enterprises,
- Excessive bureaucracy, and a complex and cumbersome tax system and regulatory system,
- The scarcity of inputs and the inexistence of input markets, in which economic actors in the non-state sector (particularly self-employed workers and entrepreneurs) can procure essential inputs at prices determined by the market forces of supply and demand,
- Restrictions that limit self-employment to low-skill activities, preventing high-skilled individuals employed by the state from participating in self-employment and entrepreneurial activities,
- Prohibitions that prevent self-employed workers, entrepreneurs, and SMEs from freely joining global supply chains, importing essential inputs, and exporting their products and services,
- Prohibitions and restrictions on foreign direct investment (FDI),
- Limited access to diverse sources of financing (i.e., equity financing, debt financing, bank credits, etc),
- Monetary dualism, and
- Low salaries and pensions and the relatively-low purchasing power of the majority of Cuban households.

The labor market reforms introduced in Cuba since 2010 remain insufficient to stimulate or incentivize the development of a vibrant entrepreneurial class capable of

significantly improving the incomes and living standard of the Cuban population (Bahamonde, 2018). Achieving these goals would require more profound and far-reaching structural reforms beyond the labor market (Mesa-Lago,2018). The most immediate should include:

- Reduction (or elimination) of excessive and complicated bureaucratic processes and procedures,
- Expanding the scope of self-employment to include high-skilled activities, granting self-employed workers with greater freedom and autonomy, and clarifying self-employment regulations; allowing university graduates and professionals to participate in self-employment activities, capitalizing on existing human capital, and providing them with the opportunity to improve their household incomes and living standards,
- Reducing the tax rates applied to the non-state sector; eliminating taxes on the utilization of labor, and replacing them with different tax structure that would not penalize hiring more labor,
- Improving existing rules and regulations related to contracts between the non-state sector and state-owned enterprises,
- Creating wholesale input markets to allow non-state sector to obtain essential inputs at prices consistent with their purchasing power,
- Extending agricultural usufruct contracts, further decentralizing the commercialization of agricultural products, eliminating production quotas and price controls, and permitting the expansion of the non-state sector in agriculture to incentivize agricultural production and encourage investment in this vital sector of the Cuban economy,
- Expanding the lease terms between the state and non-agricultural cooperatives to provide cooperative members with a greater degree of legal certainty and to stimulate investment,
- Reducing the procedures required for the non-state sector to obtain micro-credits from state banks and expanding and diversifying the sources of credit and financing available to non-state economic actors,
- Allowing the expansion of entrepreneurs and members of non-agricultural cooperatives to all provinces of the country and abroad; recognizing their right import and export and to join global supply chains,
- Authorizing self-employed workers form associations or independent groups to advocate for their interests independent of the state, and finally,
- Expanding access to the Internet, reducing its costs, and authorizing other forms of advertising, marketing and promotion.

While far from a panacea or a “fits-all” solution, these reform policies will likely contribute to further expanding Cuba’s non-state sector, particularly self-employment, entrepreneurial activities, and small-and-medium enterprises (SMEs). The experiences of other post-socialist transition economies suggest that a greater expansion of Cuba’s

emerging non-state sector would contribute to tangible improvements in incomes and standards of living for a large sector of the population, the creation of new jobs, increases in the supply of products and services, capital formation, and long-term economic growth.

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The Time Effect of Financial Literacy and Technology

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ABSTRACT

Financial capability is critical for an individual's ability to survive economic hardship, especially since the outbreak of the Covid-19 pandemic. Asaad (2015) indicates financial confidence is important across all financial knowledge levels. Additionally, financial knowledge acquired through financial education demonstrates a time effect on individual's financial behaviors (Wagner and Walstad 2019). This study uncovers how the short-term and long-term financial behaviors of adults can be influenced by various factors affecting financial knowledge and financial confidence after controlling for individual financial constraints and other socio-economic variables. Moreover, we find that being tech savvy can have opposite consequences to one's financial capability.

INTRODUCTION

Financial literacy, as basic reading and writing skills, has never been so important to people in today's complex financial world. Financially literate participants in the labor market have a better understanding of overall economic performance and react more wisely during economically challenging times. Additionally, the overall climbing college enrollment rate for 18-24-year-olds to 41% in 2018 (Digest of Educational Statistics, 2019), together with increasing college tuitions and costs, have been largely associated with unprecedented increases in student loan debt. Inadequately financially literate individuals are closely associated with personal finance issues such as having low savings rates, feeling over indebted, and making poor financial decisions (Lusardi & Mitchell, 2014). Consequently, lack of financial literacy will have a profound impact on personal wealth in the long term which amplifies wealth inequality. Between 30% - 40% of wealth inequality has been attributed to the gap on financial knowledge (Lusardi, Michaud, Mitchell, 2017).

As suggested in Remund (2010), financial literacy is a measure of how well individuals understand financial concepts and confidently apply the skills to manage personal finances through mindful short-term financial decisions and long-term financial planning in a complex economic world. As integrated in the

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synthesis of financial literacy concepts, how well people manage their money and control their finances, that is, financial capability, is revealed by their financial behaviors and outcomes.

The purpose of this study is to examine the effect of financial literacy on financial behavior from the time perspective. The main contributions of this study are twofold: first, our study demonstrates the time effect of financial literacy on financial behavior using 2018 National Financial Capability Survey data; second, the study finds tech-savvy consumers tend to be associated with more rational long-term financial behavior. The rest of the paper is organized as follows: Section II provides an overview of existing studies; Section III introduces the 2018 National Financial Capability Survey (NFCS); empirical results are discussed in Section IV and Section V concludes with a discussion on future research.

LITERATURE REVIEW

Many studies have examined the effect of financial literacy on financial behavior. For instance, a study by Boisclair, Lusardi and Michaud (2017) shows retirement saving is strongly linked to financial literacy through a survey in Canada. While the findings are inconclusive, the question depends on the approach of the study, how financial literacy is measured and what aspect of financial behavior is the focus. Despite causality concerns on the correlational studies, the significant association found between financial literacy and financial behavior in empirical evidence has indicated the line of study is worthy of attention.

There has been no general consensus on the definition of financial literacy since it was first introduced by the Jump$tart Coalition for Personal Financial Literacy in 1997 (Lusardi and Mitchell 2014; Remund 2010). Initially, the term financial literacy was defined as ‘‘the ability to use knowledge and skills to manage one’s financial resources effectively for lifetime financial security.’’ The later discussions on the definition of financial literacy tend to focus on at least one aspect of financial knowledge, aptitude and confidence on making financial decisions. While conceptual financial literacy requires a synthesis of several domains, most research relies on a test measure of what individuals understand about financial concepts, varying from the Big Three questions on compounding interest, risk diversification and inflation, to a wide range of questions on math, personal finance, economics or a mix of all. In addition to traditional objective measures of financial knowledge, through the percentage of correct answers to multiple-choice questions on financial concepts, researchers adopt subjective measures on perceived financial knowledge or self-assessed financial literacy to capture additional factors leading to various financial behaviors. Comparing actual financial knowledge and the perception of understanding financial concepts, prior studies indicate individuals tend to be overly confident about what they know about financial literacy, which can be a problem especially when they are not aware of the bias (Lusardi and Mitchell 2014). Allgood and Walstad (2016) use a combined actual and perceived financial literacy measure to investigate how the overall financial literacy measure affects the financial outcomes on credit cards, investments, loans, insurance and financial advice. Based on the 2009 U.S. National Financial Capability Survey, they find both actual and perceived financial literacy tend to influence financial behavior across all five categories.

The risk behavior of an individual can also influence their financial behavior. Previous research has found that risky behavior is associated with financial behaviors such as incurring late fees, increases in interest rates and greater borrowing costs (Lyons 2007, 2008; Robb, 2011). While looking at college students, Gutter and Copur (2011) find that risky behavior can have an impact on the financial well-being of an individual. Xiao et al. (2014a), examine different measures for risky behavior and discovered that the greater the individual's financial knowledge, both subjective and objective, the less risky paying and borrowing behaviors.

When examining financial literacy in the time perspective, there are both short- and long-term financial decisions. Henager and Cude (2016) state "long-term financial behavior referred to retirement saving and investing behavior, whereas short-term financial behavior referred to spending and emergency saving behavior." Variables associated with long-term financial behavior include retirement plans and investments outside of an individuals' retirement accounts (Henager and Cude, 2016). Other research by Wagner and Walstad (2019) define long-term financial behaviors as behaviors involving planning for the future including having a three-month emergency fund, savings account to save for the future, having financial investments, and understanding retirement needs. Short-term financial behavior factors include an individual having an emergency fund, comparing spending to income, and overdraft activity (Heanger and Cude, 2016). Wagner and Walstad (2019) define short-term behaviors as those that involve money or credit management behaviors including timely payment of bills each month, managing checking accounts to avoid overdrafts, paying off credit card balances, and making timely payments to mortgages. Remund (2010) concluded that planning is long-term financial management while decision-making skills are short-term financial management.

When examining the different factors that affect short- and long-term behavior, Heanger and Cude (2016) found that individuals with greater financial literacy had greater long- and short-term financial planning and behavior. General education and income were found to be significantly positively related with short- and long-term financial behaviors (Heanger and Cude, 2016). Wagner and Walstad (2019) and Beverly, et al. (2003) concluded that financial education has more of an effect on long term financial behaviors rather than short-term behaviors. Bernheim, Garrett, and Maki (2001) reported that financial education in high school increased long-term financial behaviors, including savings and net worth. Heanger and Cude (2016) found that for "the long-term behaviors, the strongest relationship shifted from subjective knowledge (confidence) for younger age groups to objective knowledge for the older age groups."

Acquiring financial knowledge can be costly and the levels of financial literacy vary across demographic variables. Knowledge gaps on financial literacy exist by educational level and age. Lusardi and Mitchell (2011a, 2014) reported a lack of fundamental computation skills and basic understanding of economic concepts were found among many aged 50+ individuals and young adults. Monticone (2010) found that people with lower incomes found it too costly and with fewer incentives than individuals with higher income to acquire financial literacy on their own. Align with seminal work of Becker (1975), consumers acquire financial knowledge to meet heterogeneous needs on personal finance issues. To address the individual

differences on financial knowledge acquisition, additional factors such as age and educational level should be included for the concerns of omitted variables. Fernandez, Lynch Jr., and Netemeyer (2014) reported the diminishing effect of financial literacy when controlling for demographics and psychological traits, such as willing to take investment risks.

DATA

The data for this study came from the 2018 National Financial Capability Study (NFCS). The largest component of the NFCS, the State-by-State Survey, was conducted across a large and diverse sample that provided a comprehensive analysis of the financial capability of the national population as a whole. The survey was conducted online from June through October 2018 among a nationally representative sample of 27,091. The final sample used for this study was 20, 904 after dropping the observations where the respondent chose "prefer not to say" as their answer to the questions dealing with financial behaviors, and subjective financial knowledge and management questions. An answer of "Prefer not to say" or "don't know" was coded as incorrect in the case of the objective financial knowledge questions.

The survey questionnaires were divided into ten sessions: 1. Demographics, 2. Financial attitudes and behaviors, 3. Banking, 4. Retirement accounts, 5. Government benefits, 6. Home and Mortgages, 7. Credit cards, 8. Other debts, 9. Insurance and 10. Self-Assessment and literacy. Descriptive statistics[1] on demographic characteristics of the sample are summarize as follows. The sample contained 44% male. As for marital status, 53% of the sample were married, about 30% were single, 13% were divorced or separated, and 44% were widowed. As for education, about 13% of the sample had less than high school education, 18% had a high school degree, 34% had some college education, about 22% had a college degree only, and 13% had some post graduate education. As for age group, each of the six groups ranged from 8% to 22% of the sample. About 74% of the sample were white and about 35% had at least one child. About one-third of the sample earned annual income below $75,000, and about 19% of the sample was making more than $100,000 a year.

DEPENDENT VARIABLES

We computed two measures of financial behavior index: short term and long term. The short-term financial behavior index was created based on three survey questions that asked if the respondent: 1, always paid off a credit card bill in full; 2, spent less than or equal to his or her income, and 3, overdrew his or her checking account occasionally. If the respondent answered "yes" to the questions that the respondent always paid off the credit card balance in full, and if the household spending was less than or equal to the income, the variables were coded 1, and was otherwise coded 0. On the other hand, if the respondent answered "no" to the question about overdrew their checking account ever, the variable was coded with 1, and 0 otherwise. The overall index was created by adding the responses to the three questions that ranged 0 – 3, and the average is 2.05. A binary dependent variable – as a measure of short-term financial behavior – was assigned 1 if the overall index is above 2, otherwise 0. That means if the respondents engaged in

the three behaviors, they were assumed to have good financial behavior. We also used each of the four variables as alternative measure of short-term financial behavior. As reported in Table 1, about 82% of the respondents had never over drafted their checking account, 81% spent less than or equal to their income over the past year, and 56% were always paid their credit card bill in full. About 38% of the respondents were engaged in all of the three behaviors.

Table 1: Short-term and Long-term Financial Behavior

	Responses			
	Yes Index=1		No Index=0	
	N	%	N	%
Short-term Financial Behavior				
Always paid credit card bill in full	9,834	56.2	7,652	43.8
Spent less or equal to income	16,963	81.2	3,941	18.8
Not overdraft checking account	16,175	81.9	3,552	18.1
Overall short-term variable	7,817	38	13,087	62
Long-term Financial Behavior				
Has Saving account	16,354	78.2	4,550	21.8
Has non-retirement Investments	7,876	37.7	13,028	62.3
Figured out retirement needs	13,424	64.2	7,480	35.8
Has Retirement plan	14,623	70.0	6,281	30.0
Had Emergency fund	11,386	54.5	9,518	45.5
Overall Long-term variable	12,324	59.0	8,580	41.0

Some financial decisions are complex, future-oriented and requires planning (Hilgert, Hogarth, and Beverly, 2003). A long-term financial behavior index was created based on the responses to five questions that asked if the respondent: (1) had an emergency or rainy day fund; (2) had a saving account, money market account or CDs; (3) had investments in stocks, bonds, mutual funds, or other securities that are outside of retirement accounts; and (4) had ever tried to figured out their retirement needs, and (5) had any retirement plans either through an employer or not. All variables were coded 1 for yes and 0 for no. The index was created by adding the responses to the five questions that ranged 0 – 5, and with the average value of 2.76. The overall measure of long-term behavior was created as a binary variable, and coded as 1 if the overall index is more than 2, and 0 otherwise. As indicated in Table 1, about 59% of the respondents were engaged in more than the two items of long-term financial behavior. Each of the listed five indexes were also used individually as alternative measure of long-term financial behavior. About 78% of the respondents have a saving account, money market account or CDs; 38% were invested either in stocks, bonds, mutual funds, and 64% had already figured out their retirement needs. About 55% of the respondents had an emergency or rainy-day fund that would cover expenses for three months in case of sickness, job loss, economic downturn or other emergencies.

INDEPENDENT VARIABLES

Consistent with the existing literature (Asaad 2015, Xiao and Porto, 2016, Wagner and Walstad, 2019), financial literacy variables were defined to reflect either the actual knowledge or the perceived knowledge of basic financial literacy. The actual knowledge variable was constructed from responses to six questions assessing knowledge about interest accrual, inflation, bond prices, mortgage, risk and bond duration. The responses for each of the six questions were re-coded as a dummy variable, coded 1 for a correct response and 0 otherwise. As indicated in Table 3, about 74% and 76% of the responses were answered correctly for the questions related to interest accrual and mortgage, respectively. On the other hand, only one-third of the responses related to bond prices and bond duration were correct. The overall score was computed by adding coded responses horizontally for the six questions, that ranged 0 to 6, 0 being none of the six questions were answered correctly and 6 being all were responded correctly. The average score was 3.11. A binary financial actual knowledge variable was created by assigning 1 if the overall score is above the average score, 3, and 0 if not. That means those who answered 4 or more questions correctly were considered to have good financial knowledge, and those who answered less than 4 questions correctly were considered lacking basic financial knowledge or financial literacy. Only 43% of the respondents answered at least four questions correctly and thus, had good financial knowledge.

Table 2: Actual and Perceived Financial Knowledge

	Correct Response (Financial Literacy=1)		Not Correct Response (Financial Literacy=0)	
	(1)	(2)	(3)	(4)
Questions	N	%	N	%
Actual(objective) Financial literacy				
Interest Accrual	20,138	74	6953	26
Inflation	15,611	58	11,480	42
Bond	7,288	27	19,803	73
Mortgage	20,545	76	6546	24
Risk	12,396	46	14,695	54
Bond Duration	8,428	31	18,663	69
Overall Score (>3)	11,709	43		
Perceived (Subjective) Financial literacy	12,181	58	8,723	42
Current financial condition	9,246	44	11,658	56
Overall financial knowledge	14,966	72	5,938	28
Day-to-day financial matters	10,581	51		
Overall score (> 6)				

The subjective, which assessed perceived financial knowledge or financial confidence, was constructed based on three survey questions: (1) how respondents were satisfied with their current personal financial condition, and the responses were measured on a scale of 1 (not at all satisfied) and 10 (extremely satisfied), (2) how respondents assess their own overall financial knowledge on scale of 1 (very low) to 7 (very high), and (3) whether the respondents were good at dealing with the day-to-day financial matters, which was scaled from 1 (strongly disagree) to 10 (strongly disagree). On average, respondents rated their current financial condition, overall financial knowledge and day-to-day financial matters as 5.72, 5.13 and

5.76 respectively. Table 2 shows about 58% of the respondents rated themselves as highly satisfied with their current financial condition, whereas 44% rated their own financial knowledge above the average and 72% rated themselves as very good (above average) in handling day-to-day financial matters. A composite confidence measure was created by adding all the three measures and coded as binary, 1 if the overall score is higher than 6 (5.7 being the average score) and 0 if not. About 51% of the respondents scored above the average score, meaning they were highly confident in handling their finance.

EMPIRICAL RESULTS

Logistic regression was used to explore how financial literacy affect financial behaviors. Table 3 in appendix shows the estimated average marginal effects in which the dependent variable measured short-term financial behaviors (column 1 – 5) and long-term financial behaviors (column 6 – 10). The observed financial knowledge positively and significantly affects financial behavior. Individuals with a good financial knowledge, 4.7% - 9.7% more likely to engage in good financial behavior in the short-term. In the long-term, individuals 8% - 10% more likely to engage in a good financial behavior. We notice that the marginal effects from the long-term regressions are larger than the corresponding marginal effects from the short-term regression. This shows that the actual financial knowledge affected the long-term financial behavior at a much higher rate than short-term financial behavior.

Financial confidence was measured as a binary variable; 1 if the overall confidence is higher than the average index, 0 otherwise; was positive and significant in both the short-term and long-term regressions. The marginal effects appeared to be slightly higher in the short-term models (column 1 – 5) than the long-term estimation results (column 6 – 10). This could be due to the fact that people got timely feedback for the short-term financial responsibilities. For example, if they got penalized due to not paying their credit card balance in full, their perception in handling their finance would be more pronounced in short-term than long-term financial behavior. Consistent with the literature, financial education that people received either in high school or college didn't have a significant impact on short-term behavior, but had a positive and significant impact on long-term financial behavior. Specifically, those who received financial education in college were 3.4 % - 4.6% more likely engage in good financial behavior, and in short-term, and those who received from high school were 3.9% - 4.5% more likely to have good financial behavior.

Technology has been dramatically changing the way people handle personal financial transactions, everything from online and mobile banking and virtual wallets to bar code-based mobile payments and cryptocurrencies. In addition, the ease of communication has allowed remote and contract workers to work on their own terms, increasing the size of the workforce in the gig economy. The emergence of the gig economy forced people to use various online applications such as InstaCart and DoorDash for grocery and meal delivery, and rideshare apps like Uber and Lyft. Even if there is no consensus as who qualifies as a gig worker, Bureau of Labor Statistics estimated that there are 26 million gig economy workers in the nation. In our regression, we control how comfortable people are in using technology for managing their finance, and defined as tech savvy.

Four items were selected from the 2018 NFCS survey and recoded as binary variable to measure tech savvy; (1) how often respondents used their mobile phone to pay for a product or service in person at a store, gas station, or restaurants; (2) how often do respondents used mobile phone to transfer money to another person; (3) how often they used websites or apps to help with financial tasks such as budgeting, saving or credit management, such as Credit Karma or GoodBudget; (4) how often they have took on a work assignment through a website or mobile apps such as Uber. If the respondents answered "frequently" or "sometimes" for each of the above four questions, the corresponding variables - Mobile use in person, Mobile use for transfer, Web and App for personal use, and Web and App use for work – were coded as 1, otherwise 0. In addition, we constructed the overall index (Tech Savvy) by horizontally adding all the above four variables. About 39% of the respondents never used their mobile, website or any application to manage their finance. The tech savvy is a dummy variable coded as 1 if respondents were affirming at least two of the four questions.

As shown in Table 3 in Appendix, tech savvy variable was consistently negative and significant in the short-term model, and positive and significant in the long-term model. That means, people may use technology recklessly and behave irrationally in terms of managing their short-term finance such as overspending or override their credit limit. On the contrary, with time people may engage in more rational long-term financial behavior. We also checked whether the disaggregated four tech measures have different impact on financial behavior. As indicated column 5 and 10, the use of web and application tend to have a negative and significant impact on short-term financial behavior, and have positive and significant impact on the long-term behavior.

As a robustness check[1], instead of using the aggregate measure of financial behavior, the three short-term and five long-term measures of financial behavior were used. Financial knowledge amongst respondents tended to be insignificant in predicting the probability of people always paying their credit card bill in full, whether they spent less or equal to their earnings, and not over-drafting their checking account. However, actual financial knowledge turned out to be very significant predicting whether they had emergency funds, saving accounts, a retirement plan, non-retirement investments, and had figured out their retirement needs. The perceived knowledge or confidence was significant in predicting both short-term as well as long-term behaviors. The interaction term between objective knowledge and perceived knowledge of finance was included in the regression. Across all of the regressions, it turned out to be positive and significant. That means financial confidence backed by knowledge would predict both short-term and long-term financial behavior significantly. Consistent with the previous results, the tech savvy variable was negative and significant in short-term models, and positive and significant in long-term models. However, the interaction term between tech savvy and financial confidence variable is negative and significant across all the shot-term as well as long-term models

CONCLUSION AND FUTURE DISCUSSION

The study examined the factors influencing short-term and long-term financial behaviors of individuals, after controlling for individual financial constraint and other socio-economic variables. After describing the data, we found that individuals with a good financial knowledge, were more likely to engage in good financial behavior in the short-term and long-term. Consistent with the literature, financial education in high-school or college did not have a significant impact on short-term financial behavior. However, there was a positive and significant impact of financial education on long-term financial behavior, specifically those with a college education. Moreover, being tech savvy was found to have mixed results on individuals' financial behaviors. The tech savvy variable was consistently negative and significant in the short-term model. However, the tech savvy variable was positive and significant in the long-term model. This could mean that technology allows risky individuals to behave imprudent in the short-term, making it easy for individuals to overspend. However, over the long-term individuals may engage in more rational long-term financial behavior using technology. In future research, we hope to examine other respondents from a school with students who are not the average college student population.

ENDNOTES

1. These summary statistics and regression results are available from the authors upon request.

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APPENDIX

Table 3: Logistic regression predicting financial behavior

	Short-term Financial Behavior					Long-term Financial Behavior				
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Financial knowledge	0.0977***	0.0689***	0.0605***	0.0469***	0.0470***	0.103***	0.103***	0.0895***	0.0802***	0.0803***
	(0.00616)	(0.00622)	(0.00625)	(0.00611)	(0.00611)	(0.00560)	(0.00563)	(0.00560)	(0.00549)	(0.00548)
Financial Confidence	0.266***	0.263***	0.243***	0.186***	0.184***	0.218***	0.212***	0.176***	0.132***	0.132***
	(0.00587)	(0.00564)	(0.00593)	(0.00612)	(0.00613)	(0.00477)	(0.00481)	(0.00512)	(0.00534)	(0.00536)
Finance Education in HS		0.00705	0.00402	0.000801	0.00299		0.0446***	0.0402***	0.0388***	0.0374***
		(0.00987)	(0.00981)	(0.00956)	(0.00955)		(0.00926)	(0.00913)	(0.00895)	(0.00895)
Finance Education in College		-0.0109	-0.0171*	-0.0146	-0.0142		0.0455***	0.0338***	0.0354***	0.0345***
		(0.00967)	(0.00962)	(0.00930)	(0.00930)		(0.00976)	(0.00962)	(0.00941)	(0.00940)
Tech Savvy		-0.0511***	-0.0533***	-0.0464***			0.0316***	0.0227***	0.0295***	
		(0.00682)	(0.00682)	(0.00669)			(0.00635)	(0.00631)	(0.00619)	
Mobile Use in person					-0.00209					0.000615
					(0.00699)					(0.00641)
Mobile use for transfer					-0.0418***					0.00921
					(0.00708)					(0.00645)
Web and App for personal use					-0.0341***					0.0354***
					(0.00639)					(0.00594)
Web and App use for work					0.00447					0.0235***
					(0.00987)					(0.00879)
Pseudo R2										
Observations	20,904	20,904	20,904	20,904	20,904	20,904	20,904	20,904	20,904	20,904

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1. The marginal coefficients of other control variables (gender, age, education level, employment status, marital status, income, race, risk tolerance and credit score) are not reported

How Long Would it Take for the Effects of COVID-19 Pandemic of 2020 to Filter into the U.S. Economy?

Rolando Santos[1] and
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ABSTRACT

The current COVID-19 pandemic (which started in March 2020), has started to take its toll on the United States' economy. Real gross domestic product (GDP) declined 4.8% in the first quarter of 2020. Unemployment claims rose significantly as lockdowns were implemented by many state governors. In addition, retail sales plunged a record of 8.7%, as closed malls, restaurants, factories, and mines pushed down the U.S. retail market. Also, industrial output plunged at the steepest rate in more than 70 years based on recent data provided by the Federal Reserve. This paper analyzes the impact of the pandemic on the overall economy and determines the length of time for this shock to filter into the economy. Using a vector autoregression (VAR) and a Bayesian vector autoregression (BVAR), this study analyzed the impact of COVID-19 on unemployment, stock market volatility, retail sales, and industrial production. This paper examines a practical approach to model the U.S. economy. We study the effects on the macroeconomic determinants exposed to supply shocks associated with the COVID-19 pandemic. The study looks at variance decomposition and the impulse response function to assess how long it would take for this shock to filter into the real economy and discusses the possible recovery time. These findings demonstrate a widespread lack of attention to the "unforeseen" (until now) supply shock to fully and correctly assess the consequences for salient macroeconomic variables. Overall, the findings carry clear implications for the role of COVID-19 shocks on the real economy.

Introduction

When the news of the COVID-19 pandemic spread in the United States, there was a series of closures of business establishment in the middle of March 2020. It started in San Francisco, California then other states followed such as Ohio, New York, and many more. With these closures, the unemployment rate has skyrocketed and so goes the rest of the economy. The purpose of this paper is to examine the effects of COVID19 and determine its implication on the United States' economy. The negative effects of such a pandemic can affect factors like GDP, unemployment, and the stock market. Furthermore, this study would look at the filtering effects of such shock through variance decomposition. This paper would look at the length of time at which such shock can filter into the economy. We would also like to address the issue of how long it would take for the economy to recover as a result of such shock. Different scenarios would be given to analyze such shocks.

In March 2020, the number of people filed for unemployment has gone up to 6.6 million workers (*Wall Street Journal*, April 30, 2020) as the coronavirus hit the US economy marking an abrupt end to the nation's historic, decade-long run of job growth. The number of Americans filing for claims was nearly five times the previous record. Millions of US businesses have announced layoffs or furloughs, as their cash flows dry up. Several state and local authorities have ordered non-essential businesses to close in response to the novel coronavirus pandemic, bringing the great American job machine to a sudden halt as shown in figure 1 shown in the appendix. Retail sales, a measure of purchases at stores, gasoline stations, restaurants, bars, and online, fell at a seasonally adjusted

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8.7% in March 2020 (WSJ 4/16/20) from a month earlier, the biggest month-to-month decline since the record began in 1992.

Table 1. Fifteen Large Pandemic Events with at Least 100,000 Deaths

Event	Start	End	Deaths
Black Death	1347	1352	75,000,000
Italian Plague	1623	1632	280,000
Great Plague of Sevilla	1647	1652	2,000,000
Great Plague of London	1665	1666	100,000
Great Plague of Marseille	1720	1722	100,000
First Asia Europe Cholera Pandemic	1816	1826	100,000
Second Asia Europe Cholera Pandemic	1829	1851	100,000
Russia Cholera Pandemic	1852	1860	1,000,000
Global Flu Pandemic	1889	1890	1,000,000
Sixth Cholera Pandemic	1899	1923	800,000
Encephalitis Lethargica Pandemic	1915	1926	1,500,000
Spanish Flu	1918	1920	100,000,000
Asian Flu	1957	1958	2,000,000
Hong Kong Flu	1968	1969	1,000,000
H1N1 Pandemic	2009	2009	203,000

Sales at the clothing store plunged by more than 50%, while spending on motor vehicles, furniture, electronics, and sporting goods fell by double digits. The Federal Reserve separately said US industrial production – a measure of factory, utility, and mining output which includes oil and natural gas production- fell a seasonally adjusted 5.4% in March, its biggest monthly drop since 1946. Manufacturing output, the biggest component of industrial production, decreased 6.3% from the prior month, also the biggest drop since the end of World War II. Meanwhile, a measure of US home-builder confidence collapsed at a record rate, with the National Association of Home Builders saying its housing market index fell to 30 in April from 72 the prior month. US stock indexes fell, with the Dow Jones Industrial Average sliding 1.9% or 445.41 points. The SP 500 dropped 62.70 points or 2.2% (Wall Street Journal April 16, 2020.)(See Figures 2 and 3 in the appendix for real GDP and industrial production).

Past Pandemics and Its Economic Effects

Past historical pandemic data can be traced to the Middle Ages (13 or 14th centuries and its historic economic effects and highlighted in Table 1. The sources of table 1 are from (Alfani and Murphy 2017; Taleb and Cirillo 2020).

Jorda, Singh, and Taylor (2020) posited that pandemics have a long-lasting effect especially on the real rate of interest. The effects of interest on assets can last for decades (20 years on average). In some instances, it would take for the natural rate of interest to go back to its original state after 40 years. This trend was consistent in most European countries. However, when it comes to real wages, the trend after a pandemic is to increase. The upward trend in real wages can be attributed to the labor shortages as a result of deaths during the pandemic.

A 2007 paper by Thomas A. Garrett of the St. Louis Federal Reserve Bank, "Economic Effects of the 1918 Influenza Pandemic," speculates about the possibilities of a future pandemic: "Researchers at the U.S. Centers for Disease Control and Prevention calculate that deaths in the United States could reach 207,000 and the initial cost

to the economy could approach $166 billion, or roughly 1.5percent of the GDP." The long-run costs would be even higher: "up to 1.9 million dead in the United States and initial economic costs near $200 billion." Garrett brings up something the Brainerd/Siegler paper sloughed over: Other bad things were also happening to the economy at the end of the 1910s, most especially World War I, which may complicate any direct comparison of then to now. Given the "almost complete absence of economic data from the era, such as data on income, employment, sales, and wages...especially at local levels," Garrett looks for evidence in "newspaper articles printed during the pandemic, with most of the articles appearing in newspapers from...Little Rock, Ark., and Memphis, Tenn." Between that and the evidence in earlier economic studies, he finds a level of geographic variation in the disease's effects that is unlikely in our far more interconnected nation a century later. Cities, unsurprisingly, had "higher mortality rates than rural areas of the states." Little Rock saw general merchant business declines of 40 percent, and even the retail grocery business reduced by one-third. A specific department store reported a more than 50 percent cut in daily income, but at least it was still operating. Though there was a flu-related "increase in demand for beds, mattresses, and springs," the city's businesses were "losing $10,000 a day on average ($133,500 in 2006 dollars). This is an actual loss, not a decrease in business that may be covered by an increase in sales when the quarantine order is over." The Memphis Street Railway reported that 124 of its 400 employees were too sick to work on one day. A depopulated telephone company begged the public to make fewer unnecessary calls. Coal mine operators reported a 50 percent cut in production, with some mining camps forced to shut down from raging infections. Garrett explains the possibility of a post-pandemic increase in wage and income growth on "a greater increase in capital per worker, and thus output per worker"—which might not work out the same way from a starting point of 2020 rather than 1920. He also notes that the "fact that males aged 18 to 40 were the hardest hit by influenza had serious economic consequences for the families that had lost their primary breadwinner." (Needless to say, "loss of prime working-age employees also had economic consequences for businesses.") And "cohorts in utero during the 1918 pandemic had reduced educational attainment, higher rates of physical disability and lower-income." Yet most of the 1918 pandemic's effects "were short-term," Garrett concludes. "Many businesses, especially those in the service and entertainment industries, suffered double-digit losses in revenue. Other businesses that specialized in health care products experienced an increase in revenues. Some academic research suggests that the 1918 influenza pandemic caused a shortage of labor that resulted in higher wages (at least temporarily) for workers, though no reasonable argument can be made that this benefit outweighed the costs from the tremendous loss of life and overall economic activity." Garrett's grim conclusion: "Given our highly mobile and connected society, any future influenza pandemic is likely to be more severe in its reach, and perhaps in its virulence, than the 1918 influenza despite improvements in health care over the past 90 years. Unfortunately, a 2005 report suggests that the United States is not prepared for an influenza pandemic. Although federal, state, and local governments in the United States have started to focus on preparedness in recent years, it is fair to say that progress has been slow, especially at local levels of government" (Doherty, 2020).

We have presented a selection of our model results to outline the potential impact of pandemic influenza. Our results suggest that a pandemic of the type experienced in 1957 or 1968/69 would harm GDP of approximately 0.5% and would produce losses to household consumption of up to 1%, a small increase in government expenditure, and some minor impacts on exchange rates. Sectoral impacts from our model are small so the overall economic impact of the pandemic itself would seem to be of relatively little concern. However, the introduction of a school closure policy, even if restricted to the peak of the pandemic only, causes a large increase in the working population shock and greatly increases the economic impact of the pandemic. Under a peak pandemic school closure policy GDP loss of between 5% and 8% could result together with changes in the exchange rate of up to 2%. While many countries share a common currency, adjustments in the economies of many countries will occur in response to these exchange rate effects. Household consumption could fall by almost 13% during the pandemic and government expenditure could rise by up to 6% in some countries. These results highlight the power of pandemic mitigation policies, however beneficial from the health perspective, to magnify the economic impact of a

pandemic. The impact of school closure that we have modeled may prove a worst-case scenario since, in reality, parents may make alternative arrangements for the care of their children that will enable them to return to work during school closure, thus reducing the school closure impact, but conversely school closures may be imposed for longer than the four weeks assumed in the results we have presented which would increase the economic impact and may reduce some parents' ability to find short-term care solutions that enable them to return to work. While some mitigation policies may have a detrimental effect on the economy, our results show that the use of antivirals and vaccines may prove very beneficial in dampening down the economic impact introduced by school closures. The economic impact of school closure together with antivirals and/or vaccines is approximately twice as large as the impact of the disease itself but is much smaller than the economic impact of the scenario that considers school closure. The high rates of infection among school children, particularly if a pandemic is severe, is of great concern and it is, therefore, possible that the health benefits of school closure will take precedence over the economic cost and the effectiveness of antivirals or vaccines to mitigate the economic impacts may prove to be an important consideration. Our results for the antiviral/vaccine scenarios are limited 18 by our assumptions of their efficacy and the efficacy of such interventions will remain unknown until a pandemic arrives, but the relatively small increase in government expenditure presented in our results would seem to be justified in the light of the potential benefits of antivirals and/or vaccines. While there is much uncertainty surrounding the nature of future pandemics, the response of governments and individuals to the disease, and the effectiveness of interventions, this study highlights the need for further investigation into the potential economic impact of pandemic influenza and for further analysis of the cost and effects of both policies and interventions to mitigate disease spread. Further research into this subject would provide valuable insight to policymakers and form an important part of the preparedness plan for future pandemics. (Brown, Donald, et al, 2008) Many studies have found that population health, as measured by life expectancy, infant and child mortality, and maternal mortality, is positively related to economic welfare and growth (Pritchett and Summers, 1996; Bloom and Sachs, 1998; Bhargava and et al., 2001; Cuddington et al., 1994; Cuddington and Hancock, 1994; Robalino et al., 2002a; Robalino et al., 2002b; WHO Commission on Macroeconomics and Health, 2001; Haacker, 2004).

There are many channels through which an infectious disease outbreak influences the economy. Direct and indirect economic costs of illness are often the subject of the health economics studies on the burden of disease. The conventional approach uses information on deaths (mortality) and illness that prevents work (morbidity) to estimate the loss of future income due to death and disability. Losses of time and income by carers and direct expenditure on medical care and support services are added to obtain the estimate of the economic costs associated with the disease. This conventional approach underestimates the true economic costs of infectious diseases of epidemic proportions which are highly transmissible and for which there is no vaccine (e.g. HIV/AIDS, SARS, and pandemic influenza). The experience from these previous disease outbreaks provides valuable information on how to think about the implications of COVID-19 The HIV/AIDS virus affects households, businesses, and governments - through changed labor supply decisions; efficiency of labor and household incomes; increased business costs, and foregone investment in staff training by firms; and increased public expenditure on health care and support of disabled and children orphaned by AIDS, by the public sector (Haacker, 2004).

The effects of AIDS are long-term but there are clear prevention measures that minimize the risks of acquiring HIV, and there are documented successes in implementing prevention and education programs, both in developed and in the developing world. Treatment is also available, with modern antiretroviral therapies extending the life expectancy and improving the quality of life of HIV patients by many years if not decades. Studies of the macroeconomic impact of HIV/AIDS include (Cuddington, 1993a; Cuddington, 1993b; Cuddington et al., 1994; Cuddington and Hancock, 1994; Haacker, 2002a; Haacker, 2002b; Over, 2002; Freire, 2004; The World Bank, 2006). Several computable general equilibrium (CGE) macroeconomic models have been applied to study the impact of AIDS (Arndt and Lewis, 2001; Bell et al., 2004). The influenza virus is by far more contagious than HIV,

and the onset of an epidemic can be sudden and unexpected. It appears that the COVID-19 virus is also very contagious. The fear of 1918-19 Spanish influenza, the “deadliest plague in history,” with its extreme severity and gravity of clinical symptoms, is still present in the research and general community (Barry, 2004). The fear factor was influential in the world’s response to SARS – a coronavirus not previously detected in humans (Shannon and Willoughby, 2004; Peiris et al., 2004). It is also reflected in the response to COVID-19. Entire cities in China have closed and travel restrictions are placed by countries on people entering from infected countries. The fear of an unknown deadly virus is similar in its psychological effects to the reaction to biological and other terrorism threats and causes a high level of stress, often with longer-term consequences (Hyams et al., 2002). A large number of people would feel at risk at the onset of a pandemic, even if their actual risk of dying from the disease is low.

Individual assessment of the risks of death depends on the probability of death, years of life lost, and the subjective discounting factor. Viscusi et al. (1997) rank pneumonia and influenza as the third leading cause of the probability of death (following cardiovascular disease and cancer). Sunstein (1997) discusses the evidence that an individual’s willingness to pay to avoid death increases for causes perceived as “bad deaths” – especially dreaded, uncontrollable, involuntary deaths and deaths associated with high externalities and producing distributional inequity. Based on this literature, it is not unreasonable to assume that individual perception of the risks associated with the new influenza pandemic virus similar to Spanish influenza in its virulence, and the severity of clinical symptoms can be very high, especially during the early stage of the pandemic when no vaccine is available and antivirals are in short supply. This is exactly the reaction revealed in two surveys conducted in Taiwan during the SARS outbreak in 2003 (Liu et al., 2005), with the novelty, salience, and public concern about SARS contributing to the higher than expected willingness to pay to prevent the risk of infection.

Studies of the macroeconomic effects of the SARS epidemic in 2003 found significant effects on economies through large reductions in consumption of various goods and services, an increase in business operating costs, and re-evaluation of country risks reflected in increased risk premiums. Shocks to other economies were transmitted according to the degree of the countries’ exposure, or susceptibility, to the disease. Despite a relatively small number of cases and deaths, the global costs
were significant and not limited to the directly affected countries (Lee and McKibbin, 2003). There are only a few studies of the economic costs of large-scale outbreaks of infectious diseases to date: Schoenbaum (1987) is an example of an early analysis of the economic impact of influenza. Meltzer et al. (1999) examine the likely economic effects of the influenza pandemic in the US and evaluate several vaccine-based interventions. At a gross attack rate (i.e. the number of people contracting the virus out of the total population) of 15-35%, the number of influenza deaths is 89 – 207 thousand, and an estimated mean total economic impact for the US economy is $73.1- $166.5 billion. Bloom et al. (2005) use the Oxford economic forecasting model to estimate the potential economic impact of a pandemic resulting from the mutation of avian influenza strain. They assume a mild pandemic with a 20% attack rate and a 0.5 percent case-fatality rate, and a consumption shock of 3%. Scenarios include two-quarters of demand contraction only in Asia (combined effect 2.6% Asian GDP or US$113.2 billion); a longer-term shock with a longer outbreak and larger shock to consumption and export yields a loss of 6.5% of GDP (US$282.7 billion). Global GDP is reduced by 0.6%, global trade of goods and services contracts by $2.5 trillion (14%). Open economies are more vulnerable to international shocks.

Data and Methodology

The data for this study include macroeconomic US variables such as Real GDP, industrial production, unemployment rate, retail sales, and federal funds rate. We will initially use linear regression to determine the effects of such shock in real GDP (RGDP). The data is based on a monthly time series dating from 1995-1 to 2020-6 (source).

Initially, we will look at a linear model to establish the link between the selected variables and how they relate to each other. We will also add a dummy variable to determine the effects of the pandemic. Then, the main part

of this topic would be to look at a VAR (vector autoregressive model) to look at the dynamic effects of such shock to some selected variables and see how it filters into the economy.

The dynamic relationships among these variables are then explored using impulse response function and variance decomposition (together called innovative accounting) within a vector autoregressive (VAR) framework. Under this framework, each variable is treated as endogenous and is expressed as a linear function of its past value and the past values of all the variables in the model. Before running this model, the standard practice is to conduct the unit root and cointegration tests of the time series data since the series which are nonstationary in level may be cointegrated. Series which are integrated of order one and are cointegrated are specified as a vector error correction (VEC) mechanism. Based on this VAR approach, the forecast error variance decomposition is then used to determine the extent to which shocks such as unemployment rate or industrial production can affect GDP. The impulse response functions are employed to establish the time path of the adjustment to shocks imposed on each of the remaining endogenous variables included in the model.

Preliminary Results

We first analyze the implication of the pandemic shock to industrial production and unemployment. The pandemic shock can be traced through a shock in unemployment and industrial production as lockdown started. We first examine the unit root of each variable and test for its stationarity. We implement the Augmented Dickey-Fuller (ADF) to test whether we reject the null hypothesis that < 1. The results indicate that all three variables reject the null hypothesis and that they are all stationary at their first differences. Table 2 shows these results for the logarithms for industrial production, real GDP, and the unemployment rate.

Table 2. Table 2: Results from the Augmented Dickey Fuller Test

Variable	ADF Test	p-value
LINDUST	-5.7044	0.0001
RGDP	-14.0907	0.0001
LUNEM	-4.860354	0.0001

The next step in analyzing our model is to look at the variance decomposition of the model. The raw VAR parameter estimates are rather difficult to interpret directly. For this reason, we focus on variance decomposition and impulse response analysis. To gain a better understanding of the main channels of influence in the three-variable model, the variance decomposition is presented. A vector-autoregressive process is stationary if it has bounded means and covariance matrices and the polynomials defined by the determinant:

$$\det(I - z_1 - z_2^2 - \ldots - z_p^p).$$

The stationary property guarantees the stability condition of the systems of the simultaneous equation. Furthermore, if such a condition is justifiable for a given multiple time series, a VAR(p) may be an adequate candidate for modeling the data generation process.

Both the variance decomposition and the impulse responses are generated by analyzing the effects of unanticipated shocks in the vector moving average representation of the VAR system. The Choleski factor is used to normalize the system, so the innovation matrix is diagonal, thereby allowing one to consider experiments in which any variable or set of variables is independently shocked. The conclusions one may draw are often sensitive to normalization, or ordering chosen since changing the ordering of the equations alters the Choleski factor. Intuitively, it determines how much of the contemporaneously correlated part of the shocks to the system is attributed to each of the system variables. Variance decompositions split the k-step ahead forecast error variance of each variable into percentages attributed to innovations in each of the variables in the system. If a variable

explains any of the forecast error variance of a second variable (at all steps k), that second variable is said to be "exogenous" concerning the first.

The variance decomposition results are computed for forecast horizons of 10 periods (monthly) to allow for the complete realization of impacts due to a given disturbance. The graphs are shown in Figures 4 and 5 in the appendix while table 3 shows the results. A shock in unemployment (LUNEM) would explain an average of 1.7% in industrial production (LINDUST) and 98% of the variation in the unemployment rate accounts for itself. This simply implies that the unemployment rate is an exogenous shock that is accounted for by itself. However, a shock in industrial production (LINDUST) explains 3.7% of the variation in unemployment and almost 0% in the national output (RGDP). Although small in terms of its accountability, it has some effect on unemployment.

The impulse response function describes the response of the system of variables to an unanticipated unit shock in any one of the variables. A unit shock to a variable in the normalized system is interpreted as one-standard-deviation unanticipated movement in that variable, where the measured variance of the shocks to each variable is, in part, a function of the particular normalization chosen. We focused on the response to shocks in unemployment merely because this allows us to focus on the questions of most interest to policymakers: How a shock in the unemployment rate responds to unanticipated movements in industrial production or consumption? Figure 6 indicates the graph that shows the path of how a shock in industrial production affects unemployment and RGDP. One would notice that a shock in industrial production such as a lockdown, takes an average of 3-6 months to filter into the economy. In both cases, the filtering effect of a shock in industrial production has a negative effect especially in the first four months and stabilizes after the 6th month. The effects of the lockdown on unemployment take 3-4 months to realize as people files for an unemployment check. The shock's impact is severe in the first four months after the shock. After that, the economy tends to stabilize as a result.

Finally, the variables are examined to determine whether or not the variables are cointegrated. In a bivariate case, finding that two variables are cointegrated implies that the long-run equilibrium relationship exists between them. More particularly, two variables are said to be bivariate cointegrated if their time series are stationary in first differences (ie. they are each integrated of order one or I(1) and if the residuals from the simple regression of one variable on the other (the so-called cointegrating regression) are stationary time series (ie. integrated of order zero, I(0). These residuals can be viewed as equilibrium errors in the long-run equilibrium relationship between the two series. These results are not provided in the paper.

Table 3. Forecast Error Variance Decomposition

FEVD for LUNEM

	LUNEM	RGDP	LINDUST
0	1.000000	0.000000	0.000000
1	0.989307	0.000559	0.010134
2	0.981976	0.000844	0.017180
3	0.981792	0.000931	0.017277
4	0.981480	0.000998	0.017523
5	0.981468	0.000999	0.017533
6	0.981463	0.001000	0.017537
7	0.981463	0.001000	0.017537
8	0.981463	0.001000	0.017537
9	0.981463	0.001000	0.017537

FEVD for RGDP

	LUNEM	RGDP	LINDUST
0	0.003988	0.996012	0.000000

1	0.009490	0.989059	0.001451
2	0.010792	0.986083	0.003124
3	0.010816	0.986015	0.003169
4	0.010817	0.986014	0.003169
5	0.010817	0.986012	0.003171
6	0.010817	0.986012	0.003171
7	0.010817	0.986012	0.003171
8	0.010817	0.986012	0.003171
9	0.010817	0.986012	0.003171

FEVD for LINDUST

	LUNEM	RGDP	LINDUST
0	0.030153	0.002033	0.967814
1	0.032785	0.003877	0.963338
2	0.035390	0.014031	0.950578
3	0.035816	0.014024	0.950161
4	0.035901	0.014131	0.949968
5	0.035910	0.014131	0.949959
6	0.035911	0.014132	0.949957
7	0.035911	0.014132	0.949957
8	0.035911	0.014132	0.949957
9	0.035911	0.014132	0.949957

regression) are stationary time series (i.e. integrated of order zero, I(0). These residuals can be viewed as equilibrium errors in the long-run equilibrium relationship between the two series. These results are not provided in the paper.

Conclusion

The pandemic of 2020 wreaked havoc on the US economy very quickly. The unemployment rate has risen to about 17% with 20 million people collecting unemployment compensation. This paper accomplishes the objective of understanding how this unemployment rate and the effects of the pandemic has filtered in the economy. With the focus on industrial production and unemployment rate, the paper attempt to determine how long it would take for the shock to filter into the economy. The result suggests that the worst part of the shock happened in the next two months after the pandemic erupted and then eventually filtered into the rest of the economy within 4 to 6 months. The conclusion is still yet to change as the shock is still in the process of its filtering effect. However, policymakers should consider this in terms of planning especially on stimulus packages or monetary policies that can influence a faster recovery rate.

Extensions of this research include focusing more on the Bayesian VAR and updating the data through August 2020. We expect to see robust results and greater insights into the impacts of the pandemic on the US macroeconomy.

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Appendix

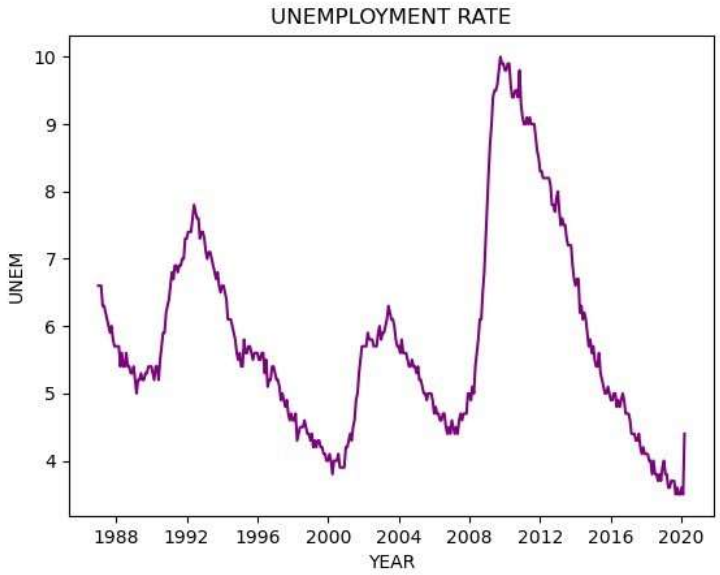

Figure 1: Graph of Unemployment Rate

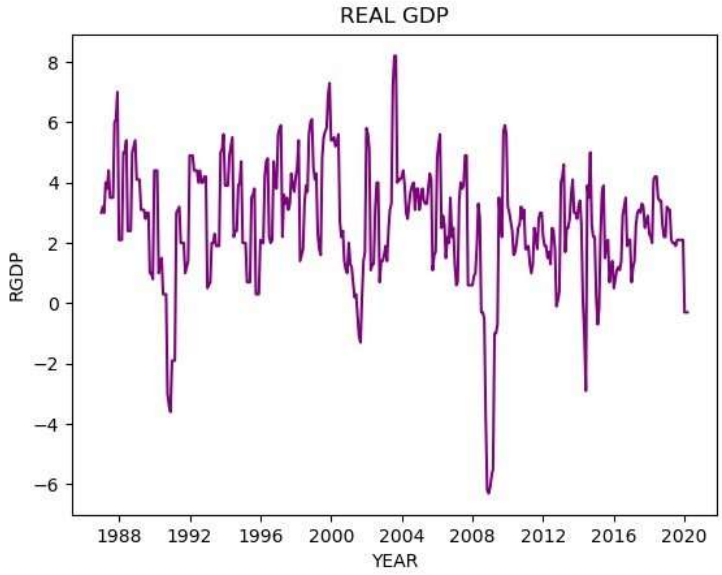

Figure 2: Graph of Real GDP

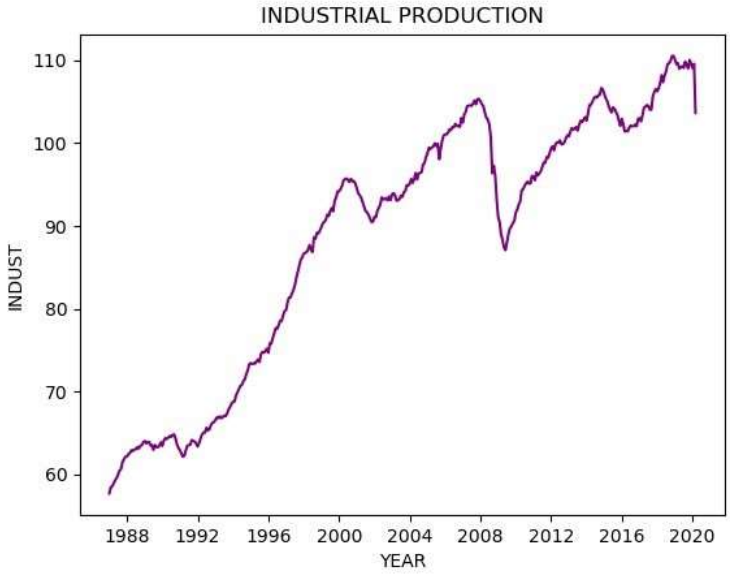

Figure 3: Industrial Production

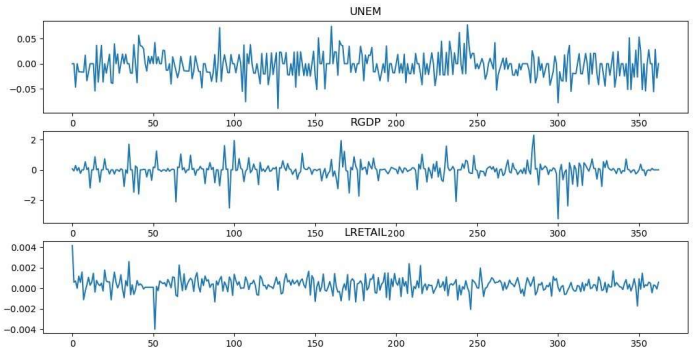

Figure 4: Variance Decomposition of the Macroeconomic Variables

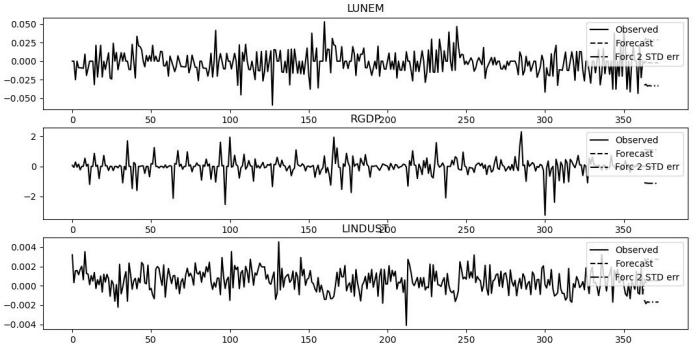

Figure 5: Forecasted Values of Macroeconomic Variables

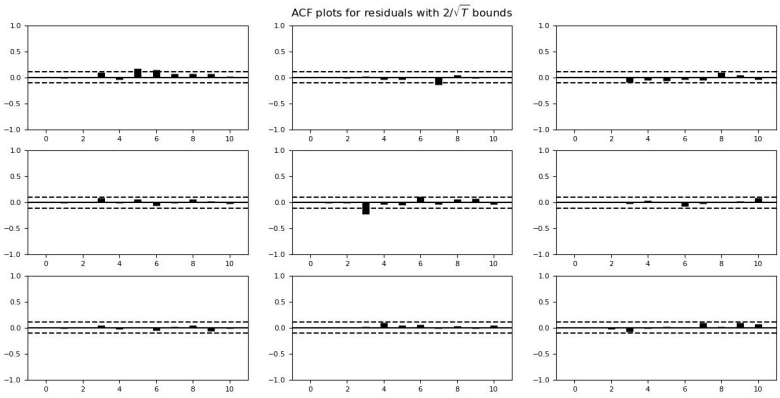

Figure 6: ACF Plots of the Macroeconomic Variables

Energy: A Biggest Hurdle in Sustainable Growth of Uttar Pradesh, a Large State in India

Babita Srivastava, Ph.D.*

ABSTRACT

Uttar Pradesh is located in the northern part of India and is the most populated state in the country as well as the most populated country subdivision of the world. It experiences power crises because the demand for electricity frequently exceeds supply significantly. Over the last 20 years, power shortages have remained within the range of 10-15%, while shortages in periods of peak demand reaches at even higher levels. This results in poor unreliable power supply with rampant power cuts and prolonged periods of low voltage. This paper will enumerate points that will help this energy crisis.

INTRODUCTION

Uttar Pradesh (UP) experiences power crises because the demand for electricity frequently exceeds supply significantly. Over the last 20 years, power shortages have remained within the range of 10-15%, while shortages in periods of peak demand reaches at even higher levels. In 2013, even a gap of up to 43% opened up between the state's demand and supply of electricity. As per figures presented in the Power Ministry's review meeting in March, the state's projected demand for summer 2013-14 is 15,839 MW showing a gap of 6,832 MW (The Times of India, 2013a). This results in poor and unreliable power supply with rampant power cuts and prolonged periods of low voltage. As a consequence, industrial investment in Uttar Pradesh has been constrained, with industries preferring to locate themselves elsewhere (Planning Department of the Government of India, 2003).

This situation also repeatedly forces the UP government to purchase power for high prices from other states in India. In 2011, for example, the UP government bought power at rates as high as Rs 17 per unit from the central pool to ensure adequate supply in the state (The Economic Times, 2011). This practice regularly incurs significant financial losses to the State Electricity Board, which, in part, have to be borne by the UP state government, constraining the state's expenditures in areas of social development, such as education and public health (Planning Department of the Government of India, 2003).

In 1999, the UP government tried to address the problems of growing power shortage and poor financial condition of the State Electricity Board (SEB) by reforming UP's power sector. The power sector was restructured in order to unbundle and privatize it. Accordingly, the SEB has been divided into three independent corporations: UP Power Corporation Limited (UPPCL), UP Rajya Vidyut Utapadan Nigam (UPRVUNL) and UP Jal Vidyut Nigam (UPJVNL) – responsible for transmission and distribution, thermal generation, and hydro generation, respectively. Another distribution

company, Kanpur Electricity Supply Company (KESCO) was formed as a 100% subsidiary of UPPCL (Comptroller and Auditor General of India, 2004). However, the UP Electricity Reform Act, formulated in 1999, had several shortcomings, which is a major reason for the problems of the UP power sector to persist until today. Besides not curtailing the enormous powers of the Uttar Pradesh Energy Regulatory Commission by making it accountable, and besides omitting the promotion of efficiency and energy conservation, the act did not address the main reasons for the financial problems of the SEB: High cost of power purchase in relation to the lower tariffs for consumers, which are determined by the UP government (no tariff adjustment), and arbitrary depreciation methods (Gurtoo & Pandey, 2001). Additionally, the unbundling of the power sector was limited and did not lead to competition (Planning Department of the Government of India, 2003).

ENERGY CAPACITY

The installed energy capacity by energy type and by section in UP are provided in table 1 and table 2, respectively. The data was collected via The PHD Chamber of Commerce and Industry and the Central Electricity Authority of India, respectively. Thermal by Coal is a primary source of energy capacity in UP, which is not different from the other states in the county.

Table 1: Installed generation capacity in March 2009 and 2010 in MW

	03.2009	03.2010
Hydro	530	520
Thermal	4120	4370
New & Renewable	400	590
Total	5050	5480

Table 2: Installed generation capacity by sector in March 2013 in MW

	Thermal		Total	Nuclear	Hydro	Renewable	Grand
	Coal	Gas	Thermal			Energy	Total
State	4923	0	4923	0	524	25	5472
Private	3090	0	3090	0	0	799	3889
Central	2749	550	3300	336	1297	0	4933
Total	***10763***	***550***	***11313***	***336***	***1821***	***824***	***14294***

ENERGY CONSUMPTION

The overall energy consumption, and the consumption by section, is provided in Table 3 and Table 4, respectively, and the data collected via the UPPCL. In 2009-10, the average per capita energy consumption in UP amounted to 387 KW/h, while the country's per capita energy consumption stands at 734 KWh in 2008.

Table 3: Total Energy Available for Sale in Million Units (MU)

Year	Total Energy Available	Transmission Losses	Total Energy Available for Sale	% of Loss
2008-09	56374	16844	39530	30
2009-10	61040	19677	41363	32
2010-11	65599	20344	45255	31

Table 4: Electricity Consumption by Sector

Year	Industrial in MU (%)	Agriculture in MU (%)	Domestic in MU (%)	Commercial in MU (%)
2008-09	10153 (25.67)	6841 (17.12)	15809 (40.02)	2925 (7.40)
2009-10	10739 (26.23)	7317 (17.87)	15894 (38.82)	3106 (7.58)
2010-11	10558 (24.50)	7891 (18.30)	16230 (37.60)	3072 (07.1)

ENERGY SUPPLY

The energy demand and supply, as well as the surplus, are provided in Table 5 and Table 6, respectively (PHD Chamber of Commerce and Industry, 2011 & Central Electricity Authority, 2011). In 2009-10, the average per capita energy consumption in UP amounted to 387 KW/h, while the country's per capita energy consumption stands at 734 KWh in 2008. High transaction and distribution losses (T&D) are boosting the yearly deficits. In 2009, UP reported distribution losses of about 38%, which are higher than the national average T&D loss of 25.4% (PHD Chamber of Commerce and Industry, 2011). The Average Energy Tariff Structure is shown in Table 7 (PHD Chamber of Commerce and Industry, 2011). The average electricity tariff for the country stands at Rs. 4.18 KW/h for large industries, while it stands at Rs. 3.4 KW/h for domestic consumers.

Table 5: Demand and Supply in Million Units (MU), and gap between those figures in %

Year	Energy Requirement (MU)	Availability (MU)	Surplus (+) / Deficit (-) (MU)	Surplus (+) / Deficit (-) in %
2011-12	76,292	64,846	-11,446	-15.0
2012-13	83,938	70,058	-13,880	-16.5

Table 6: Peak Demand and Peak Supply

Year	Peak Demand in MW	Peak Supply in MW	Surplus (+) / Deficit (-) in MW	Surplus (+) / Deficit (-) in %
2012-2013	13,940	12,048	-1,892	-13.6

Table 7: Average Energy Tariff Structure

Average Energy Charges (Rs./KWh) for Industrial Consumer	Average Energy Charges (Rs./KWh) for Domestic Consumer
3.2	2.4

STATUS OF SOLAR ENERGY IN UTTAR PRADESH

Under the State Electricity Act 2003, the various state-level electricity regulators have specified a renewable purchase obligation. Accordingly, a set percentage of power must come from renewable sources. In the case of UP, this target has been set at 5%, of which 0.5% has to be from solar energy. However, UP has failed to achieve this target by falling short of about 50% (One World South Asia, 2013). Uttar Pradesh also lags behind other states in the country in production of electricity through solar energy. While Gujarat produces 850 MW of electricity through solar energy, followed by Rajasthan at 201 MW, in Uttar Pradesh this figure is a meager. The first megawatt-capacity solar power plant had become operational in Uttar Pradesh in January 2013 in Barabanki (a 2 MW project) (The Times of India, 2013b).

SOLAR ENERGY OPPORTUNITIES IN UTTAR PRADESH

The majority of power generated in Uttar Pradesh is reliant on coal, while the limited availability and high prices of coal have aggravated the precarious power situation in UP. Hence, there is an obvious need to develop alternate sources of energy. Uttar Pradesh is blessed with a good solar irradiation to the

tune of 1,800 KW/h per m² on an annual average basis, which is considered necessary for operating a solar photovoltaic power plant. Thus, there are immense possibilities in this sector (The Times of India, 2013b). Growth of renewable energy would definitely help the state in meeting its energy requirements (Bandhu, 2012). In January 2014, the Uttar Pradesh Cabinet approved the first-ever solar energy policy of the state. Under this policy, a target of producing 1000 MW of electricity through solar energy has been set by March 2017. For the purpose of promoting production of electricity by solar energy, a U.P. renewable energy fund has been created The Times of India, 2013b). The UP government has zealously taken up the agenda of augmenting solar power generation and consumption, both on-grid and off-grid. The government had announced a solar energy policy, which promises incentives to entrepreneurs setting up solar power plants. Besides, the state has been promoting rooftop solar plants for small companies and individuals. This would not only provide a green and renewable energy source, but also reduce the burden on the grid. The 30% central subsidy provided on solar power installations has only added to the attractiveness of the proposition. After subsidy, a typical solar power system costs about Rs 1.40 lakh per kw capacity; although, the final price largely depends upon the battery strength. State government finalized agreements with seven private power players and a public sector undertaking to produce 230 MW of solar power.

Chief Minister AkhileshYadav handed out Letter of Intents to Jakson Power Solutions, Moser Bayer Clean Energy Ltd, Sree Developers, DK Infracon, Refax Energy, Azure Surya Ltd and Essel Infra. These private sector firms would together be setting up solar power plants of a total 130 MW capacity. These companies would be purchasing land directly from the farmers and are expected to be commissioned within six months after the land is in possession. The Joint MD, Jakson Power Solutions, Sundeep Gupta said that they would be investing Rs 80 crore within one year to establish a 10 MW solar plant. He said that they have identified some land parcels in the Bundelkhand region of the state and expect their project to be commissioned in 6 months' time.

Jakson Power Solutions has already commissioned a 2×10 MW solar project in Rajasthan in February this year and is ambitious on growing their solar power portfolio. "We are scouting for several opportunities and would also be exploring the option of setting up one more solar plant in Uttar Pradesh" Gupta said.

The state government has also signed an MoU with public undertaking the National Hydro Power Corporation Ltd (NHPC) to set up a 100 MW solar plant in Jalaun district of Bundelkhand region. As fossil fuels are non-renewable sources, we cannot depend on them forever. Though nuclear energy is a clean and green energy, there are always some problems associated with it. Therefore, the only option we have is solar energy because it is a nonpolluting and silent source of electricity. Most solar energy systems do not require much maintenance during their lifespan, which would mean that pouring funds into maintaining the machine will be a non-issue. Also, most systems have a lifespan of 30 to 40 years, creating long lasting energy.

Solar energy easily can be converted into electrical energy. Solar panels can convert the light energy into electrical energy. A solar panel is a group of solar cells, which works on the principle of photoelectric effect. Office buildings, schools, community roof areas can all be covered with solar panels.

In conclusion, to achieve the energy requirement in the state of UP and to maintain the economy growth, the following should be considered:

- Government should take measures and see that solar lights are used as street lights in all the areas.
- Place solar panels in the barren lands instead of keeping it away uselessly and keep these solar panels in the deserts, where they can make use of this energy with the help of a rechargeable battery.
- Efficiency of solar panels depends on the range of frequencies of light that strikes the surface. If we split the light into different frequency ranges and direct the beams onto the cells tuned to these frequencies, they can work at a higher efficiency.

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Covid-19 and the Long Island, NY Regional Economy: Pathways to Recovery

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Abstract

Long Island's economy was growing with economic indicators such as unemployment averaging well below 4 percent and average weekly earnings increasing. The Pandemic shutdown in March 2020 idled all but essential activities and work that could be conducted remotely from home. The region entered Phase 1 of the New York State's reopening plan at the end of May, 2020 with many firms and businesses slowly ramping up their operations based upon specific guidelines and social distancing rules. This study provides an overview of the region's economic conditions over the first 7 months of the Pandemic recession.

1. Introduction

Long Island's economy was running strongly through the middle of March, 2020, with economic indicators such as unemployment averaging well below 4 percent, average weekly earnings continuing to increase, and overall strong growth prospects for the rest of the year. As coronavirus cases began to surge, local city and county governments, following advice from public health officials regarding social distancing and the spread of the disease, began to order businesses to shut down, which was ultimately followed by New York Governor Cuomo ordering the closure of all non-essential businesses, the implementation of a requirement for individuals to wear facemasks in public, and extreme limits on the operation of essential businesses. The shutdown idled all but essential activities and work that could be conducted remotely from home – leading to record filings for unemployment benefits that surged dramatically from mid-March to early June.

As the spread of the virus was contained, NY State issued its NY Forward Plan in May, 2020 outlining guidelines for reopening its economy in phases on a region by region basis (Long Island, New York City, Mid-Hudson, Capital Region, Mohawk Valley, North Country, Central New York, Southern Tier, Finger Lakes, and Western New York). LI entered Phase 1 of the reopening on May 27 and economic activity had begun to return. The impacts of the shutdown on the region's economy were severe and distinctly different in many ways from those associated with an ordinary economic downturn or natural disaster. Unlike the downturn typically associated with a recession or even the normal disaster agents that strike the region, this downturn was the direct result of government intervention to moderate the impacts of public health emergency. Thus, many economic activities were put on pause with the intent to reduce social interactions for a prolonged and indeterminate period. Initially, much of the economy across the state was idled for close to eight weeks, with the exception of essential businesses and activities such as healthcare (essential medical and medical support services), essential infrastructure (transportation, hotels, utilities), essential

manufacturing (food, medical, defense, etc.), essential retail (pharmacies and supermarkets, gas stations, restaurants and bars for takeout), essential services (trash collection, mail, maintenance, etc.), news media, financial services, providers of necessities to economically disadvantaged populations, and certain types of construction, defense and national security related activities (Empire State Development,).

While the treatment of various industries and sectors across the state and the region were met with wide criticism in terms of what was considered essential and the types of firms or activities that were allowed to remain operating or reopen, there were still significant parts of the economy that continued to operate unabated, albeit in a socially distanced manner. Many retail establishments suffered serious losses, but online retail sales or retailers that were quickly able to establish an online presence flourished. Most offices were forced to close, but this did not necessarily mean that the firms or activities of the companies were halted. Many firms, local and state government offices and service providers pivoted to the use of new and emerging telecommuting tools for employees to continue to work albeit from home instead of the office. Educational services from K-12 to colleges and universities moved from traditional classroom instruction to online instruction with varying degrees of success.

This study evaluates the prospects for recovery and the potential long-term impacts of the Covid-19 shutdown on Suffolk and Nassau Counties' economy. The analysis is primarily descriptive, but we do plan to conduct more in-depth analysis using in the future.

The reaction to the public health emergency by government (at all levels) has been unprecedented in many ways. In recessionary times, policymakers within both the Federal Reserve and the Federal government usually respond by using a combination of monetary policy and fiscal policy to encourage investment (interest rate and liquidity policies) and stimulate consumer demand. The CARES act passed at the federal level provided for an expansion of eligibility for unemployment insurance, a temporary addition of $600 a week unemployment benefit (which expired at the end of July), and the Payroll Protection Loan Program (PPP) which could be used to support primarily business payroll expenses for a limited period. The Federal Reserve provided additional liquidity and loan support to the corporate and financial sector.

These policies did not prevent unemployment at the national level from rising to over 14 percent, but they did appear to maintain consumption expenditures from April through September 2020. Some small and medium sized businesses that shut down at the start of the pandemic may never reopen. Six months into the shutdown, several large retail chains indicated that they will not reopen, been sold, or filed for bankruptcy. Additionally, many firms, schools, corporate and government offices have found that a number of new and emerging technologies enabled them to continue to provide their services in alternate ways that if fully incorporated into everyday use following the health emergency portend significant impact upon the commercial real estate, hospitality and travel sectors.

The rest of this paper is organized as follows. Sections 2 and 3 provide an overview of the economic issues associated with disasters the current health emergency and an analysis of LI's economy and the impact of Covid-19. The conclusions of this study are presented in Section 4.

2. Hazardous Events and the Economy

Hazard situations present the regional economic landscape with the threat of serious and sometimes cataclysmic disaster. Alongside possible physical impact and destruction, employment and income may be affected – the result of damage to economic infrastructure, individual firms, and population displacement. In the aftermath of weather and geophysical events, recovery consists of three primary concerns -- replacement of damaged infrastructure and housing, recovery of employment and income, and the restoration of regional and interregional linkages and economic relationships. The Pandemic shutdown presents LI with similar problems albeit without the physical destruction of infrastructure and capital.

Economic geographers and economists link regional growth and development to external economies, economies of agglomeration, subcontracting activities, the urban center's role in information exchange, and intellectual spillovers (Redding, 2009; Fujita and Thisse, 2008; Candau, 2008; Overman, Rice and Venables, 2007; Fujita and Krugman, 2004). Briefly stated, growth occurs as a result of these linkages and externalities. In turn, continued growth depends upon deepening and expansion of these linkages and externalities. Both the Pandemic shutdown and Covid-19 related social distancing and business regulations may directly impact those linkages especially as some firms within the region are unable to reopen and new modes of firm operation (telecommuting technologies, etc.) result in the breakdown of some of those linkages.

Vulnerability arises from three primary sources. The first source is direct impact losses. In this case, a significant portion of Long Island's economy was temporally idled. Temporary disruptions of economic activity may lead to some in changes in the pattern of intraregional and interregional trade. And lastly, the pandemic may also lead to structural changes in the region's economy.

3. Current Thought: Economic impact of Pandemics and Covid-19

Unlike disaster agents such as weather-related events (hurricanes, tropical storms, tornadoes, flooding, wildfires) or geological phenomena (earthquakes, tsunami, etc.) that typically cause some type of physical impact on a region's infrastructure (roads, transportation systems, buildings, etc.) which in turn affect economic activity, a pandemic tends to leave the physical infrastructure in place. The economic impacts of a pandemic are instead caused by directly impacting individuals and their health and safety. Depending on the specific biological agent involved and how it spreads through the community, public health officials may be forced to shut down or limit normal social interactions – thus by all physical appearances, there is no reason for regular economic and social interactions to take place, and if they are allowed to continue, the social and economic effects of the pandemic would worsen.

In their recent study of the economic impact of the pandemic, Aliyev and Mursalli (2020) point out that while events such as these may often be referred to as Black Swan events (unforeseen events) with potential large-scale impacts, that there are numerous examples of the events through history such as the

Black Plague of the fourteenth century and the 1918 Spanish Flu. Their study on the impacts of the current pandemic is very preliminary, having been written and presented within just a few months of the world-wide spread of the pandemic. Similarly, Babuna et al (2020), in an early study of the economic effects of Covid-19's, found the potential for significant losses or decreasing profits to the insurance sector in Ghana arising from increased claims being paid out and a decrease in premiums being paid in for insurance. Chandra and Christensen (2016), based upon their analysis of the 1918 Spanish influenza, identify the pandemic influenza as a security issue that require some type of mitigation policy. Clay et al's (2018) research found that mortality rates due to the 1918 influenza pandemic were higher in cities with poorer air quality (primarily as a result of burning coal).

Keogh-Brown et al (2010), utilizing a CGE model of the UK, France, Belgium and The Netherlands, evaluated the potential impact of a possible flu pandemic, concluding that losses in each of the four countries' GDP could be as high as 2 percent. Their analysis is predicated upon illness related changes to labor and labor supply, specifically by modeling two strategies – 1) school closures that impact child-care decisions of households and 2) a vaccine with different levels of effectiveness. They conclude that more labor-intensive sectors (service oriented) will be more deeply affected than other sectors (in particular, agriculture). The authors also point out the level of economic impact from a pandemic is highly dependent upon the types of strategies that are used to combat it.

Kelso et al (2013), using a community simulation model for an Australian community of 30,000 people found that an influenza A type pandemic could have an impact ranging from $441 to $8551 per person depending upon the severity of the illness. They used an individual-based simulation model involving a population and transmission module with both epidemiological and intervention parameters, a health outcomes module, and an economic analysis module. They concluded that for pandemics with the highest level of severity following a strategy of strong and rigorous social distancing policies would lead to the lowest total social and economic costs. Conversely, these types of policies and strategies would not be realistic or acceptable for low severity pandemics.

Two recent studies, one by Lenzen et al (2020) and the other by Chernick et al (2020) provided early estimates of the potential economic impacts upon the economy. Chernick et al focused on the fiscal impacts on city finances. Using a sample of 150 cities across the United States, and combining estimates of employment loss and lost earnings in each city, and potential revenue losses in each city, they estimated potential economic impact for fiscal years 2020 and 2021. The most stable revenue cities receive is through property taxes, but sales tax revenues, individual income tax revenues, user fees and state aid in the wake of a financial downturn (as a result of the Covid-19 shutdown) may vary dramatically. They found that a city's forecast fiscal state is highly dependent upon the underlying revenue structure and the overall additional costs that the coronavirus may impose upon it. Lenzen et al (2020) focused upon the global level economy, finding that as a result of supply chain disruption, extensive country or regional wide economic and societal shut-downs, and reduced consumption and production through the spring of 2020, global

output fell by as much as $3.8 trillion and atmospheric gas emissions that contribute to global warming dropped dramatically.

There are numerous methodologies currently being used to analyze Covid-19's economic impact. One recent study by Fezzi and Fanghella (2020) used market level electric power usage to estimate the economic impact of Covid-19. They utilized daily sectoral consumption data for industrial, commercial and public services, residential, and other (transport, agriculture, forestry and fishing) from Italy, to create a times series analysis using both OLS with heteroscedasticity and autocorrelation consistent corrections (HAC) and an autoregressive structure. Their model was able to provide timely estimates of short-term economic impact relying upon easily observed market data that is reported in close to real-time. They concluded that Italy's lockdown reduced GDP by approximately 30 percent. Another recent paper by Mitra et al (2020), using Covid-19 age specific mortality rates and potential years of life lost data (PYLL), estimated the costs or impact for Germany, Italy and the United States. PYLL costs were found to be higher in the U.S. (and even higher in New York) than Italy (which was followed by Germany). They also found that individual countries should revise the PYLL figures as life expectancy has changed significantly over the years, and that there was a need for better data collection on premature deaths due to the coronavirus.

Covid-19 was first recognized as an issue in Wuhan, China in January 2020, and over a two-month period was found in both Europe and the United States. The first reports of the disease in the US started in February with some reported cases occurring in Washington, California, and New York. Lockdowns were ordered in NY by the middle of March, with significant sectors of the economy idle for approximately 6 to 8 weeks, and social distancing rules imposed. In the next section, we look specifically at both national and regional (Long Island) economic indicators to evaluate Covid-19's impacts upon the economy.

3. Covid-19, the National Economy and Long Island

Between March 2019 and March 2020, the economy was starting to show signs of slowing down. While there had been concerns as to the state of the national economy towards the end of 2019, economic activity was still relatively strong. Table 1 below shows that year over year, the unemployment rate for the US, NY State, and LI were on the rise by the end of March 2020 and had increased to 4.5 percent, 4.4 percent and 4.0 percent respectively. NY's economy had been fully operating until approximately March 15th, so the shutdown that took place was just beginning to manifest itself. From March 2020 to July 2020, LI's unemployment rate shot up from 3.8 percent to 16.1 percent in April, and then fell to between 12.3 percent and 13.8 percent from May through July (Table 2).

Table 1: Change in Employment and Unemployment March 2019-March 2020 (in thousands)

Area	Employed 3/20	Employed 3/19	Unemployed 3/20	Unemployed 3/19	Unemployment Rate 3/20	Unemployment Rate 3/19
U.S	155,167	156,441	7,370	6,382	4.5%	3.9%
NY	9020.1	9128.6	417.8	400.6	4.4%	4.2%
Nassau-Suffolk	1432.6	1425.3	58.9	53.3	4.0%	3.6%

Source: NY State Department of Labor

Table 2: LI Employment Market, March 2020-July 2020 (thousands)

	Mar	Apr	May	June	July
Civilian Labor Force	1,484.80	1,427.50	1,461.10	1,494.60	1,554.8
Employment	1,427.90	1,198.30	1,282.10	1,303.20	1,339.7
Unemployment	56.9	229.3	179	191.3	215.1
Unemployment Rate	3.8%	16.1%	12.3%	12.8%	13.8%

Source: U.S. Bureau of Labor Statistics

By September, LI had started to improve as various parts of the region's service-oriented economy were reopened. There were however many sectors that were not able to return to full capacity (retail, hospitality, restaurants, entertainment venues, sports and fitness clubs, etc.). As can be seen in Figures 2 and 3, beginning with the end of March 2020, employment on Long Island dropped precipitously, especially in the Leisure and Hospitality and Retail sectors, and only started to return in June and July.

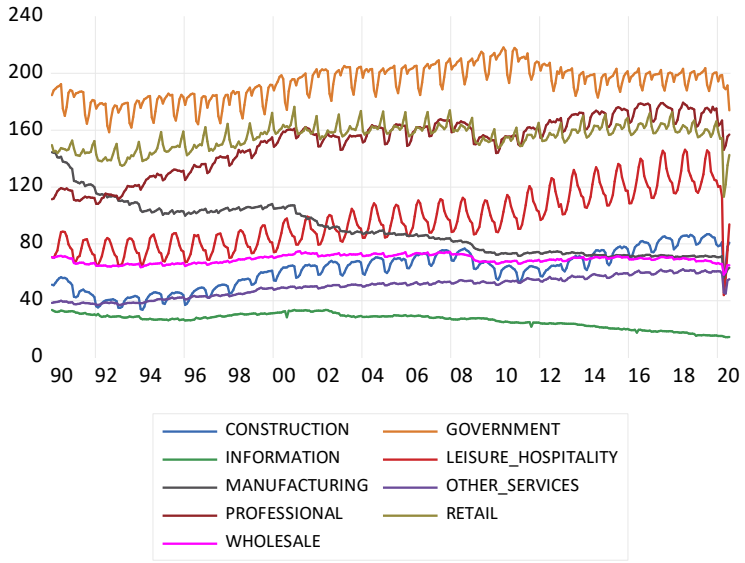

Figure 2: LI Sectoral Employment 1/1990-7/2020 (thousands)

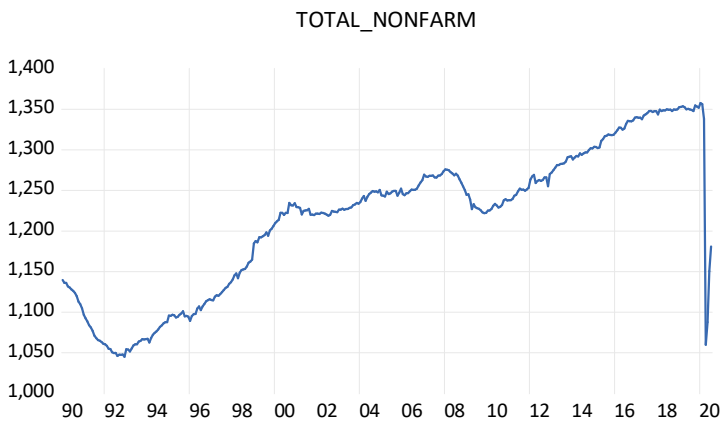

Figure 3: LI Total non-Farm Employment 1/1990-7/2020 (thousands)

A study by HRA (2020) conducted for Nassau County concluded that LI lost jobs at a faster rate than other parts of the state. They concluded that these job losses would impact local government revenues primarily through drops in sales tax revenues, and that job losses were most acute in lower paying jobs requiring lower levels of education. They also forecast that a total of 375 thousand jobs will be lost on LI, $21 billion in lost household income, and a loss of $61 billion in economic activity.

As of the end of September, there had been 92,921 confirmed cases of Covid-19 on LI, 242,311 for New York City, and 454,760 for the state. The rate of infection in the region and the state had fallen dramatically which is what paved the way for the reopening of LI's economy. Between March 14 and May 9, 2020, there were 288,787 filings for unemployment on LI, an increase of 271,124 filings over the same period in 2019. Since the start of the Covid-19 crisis in March (Figure 4), unemployment claims, which initially jumped to 60,000 per week, fell to well below 10,000. Covid testing in Nassau County ramped up from initial rates of 0 per day at the beginning of March, to up to 10,000 per day by September 1, with over 687 thousand tests conducted. Similarly in Suffolk, testing increased to up to approximately 8000 by the end of August, with a total of 696 thousand tests conducted by the beginning of September.

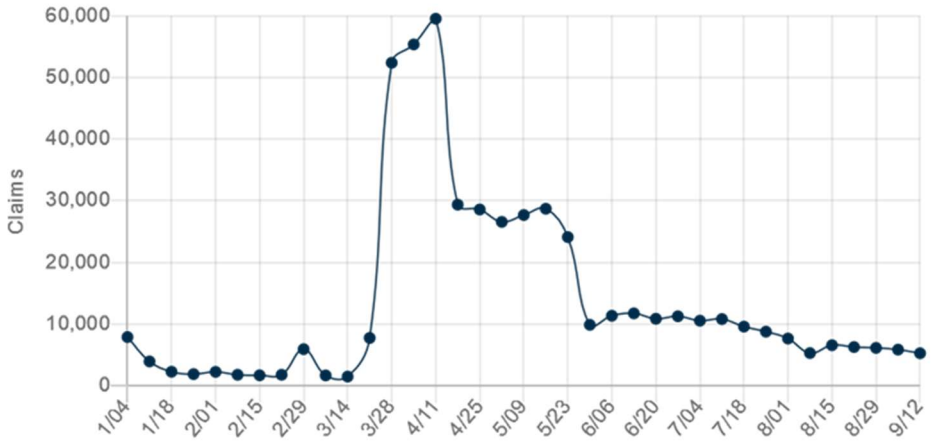

Figure 4: LI Weekly Unemployment Claim, 1/20-9/20, Source Newsday.Com

During the first quarter of 2020, there were 107,451 private establishments on LI. It is difficult to say what the impact of the pandemic shutdown has been on them, though obviously a some of these firms may not have survived two or more months of closure, as well as operating at reduced capacity as a result of social distancing rules. Over 65,000 firms on LI took advantage of the Paycheck Protection Program (PPP) that was part of the CARES Act was passed in March 2020. Both the PPP program and the added $600 weekly federal addition to unemployment benefits (which expired at the end of July) helped to prevent the economy from falling further than it did, as both helped to prop up individual and household income.

Since reopening, some markets have taken off such as housing. Real estate prices in both Suffolk County and Nassau County have been increasing with inventories in some segments of the market being snapped up relatively quickly. Some analysts have suggested that this is primarily due to people leaving NYC for the suburbs – but this was only anecdotal. It should be noted as well that mortgage rates are currently extremely low at rates of approximately 3.09 percent for a 30-year fixed rate mortgage, 3.15 percent for a 30-year fixed rate jumbo mortgage.

While LI's recovery is still underway, the Pandemic recession may have impacted the economy through multiple channels. The composition of employment on LI has been changing over time, and there is the possibility that the lingering impacts of the shutdown could accelerate already preexisting trends such as the secular decline in manufacturing from 12.6 percent of total employment in the early 1990's to below 9 percent in 1999, and to 5.2 percent in January of 2020. Other sectors such as retail trade which while declining, have declined at a much slower rate having gone from 13.12 percent in 1990 to 11.7 percent in January of 2020, are now more threatened by online retail competition that has flourished throughout the Pandemic shutdown.

4. Conclusions

A disaster may have long run impact on the regional economy. While certainly not limited to these effects, the principal long run consequences of disaster are 1) permanent changes in employment and income, 2) acceleration of preexisting economic trends, and 3) changes in growth and development.

The Covid-19 Pandemic has had tremendous impact on LI's economy through September of 2020. It is still hard to predict the path of the economy at this point, and much depends on how quickly the public health component of the pandemic is resolved. The analysis presented is primarily descriptive. We plan on conducting a more comprehensive and full analysis to evaluate the costs to the Island's economy as well as forecast the possible future path of the region using an econometric forecasting model.

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