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The Supplier Shield: COVID-19 Effects on Suppliers of Highly Affected Industries

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Abstract

This paper examines the effect Covid-19 has on hard-hit industries and their suppliers. By looking at the widening of credit spreads on corporate bonds, a shield can be observed through the disproportionate way Covid affects hard-hit companies compared to their suppliers. The dataset looks specifically at three highly affected industries which are accommodation, air transportation, and full-service restaurants. This paper runs a linear regression that looks at the effect that being one of the main 3 frontline industries has on credit spreads of corporate bonds versus that from being a supplier of these industries. The regression highlights the effects that the specific events of Covid-19 and the Federal Reserve's announcement to offer support have on these different industries as well. The paper concludes that the effect of Covid-19 in widening credit spreads is more associated with frontline industries as compared to their suppliers. This indicates that during policymaking, the disproportionate effect some industries see during a financial crisis caused by a pandemic or other similar event should be studied and considered when the Federal Reserve offers financial aid.

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1. Introduction

The Covid-19 pandemic caused global panic and a global financial crisis. Unprecedented economic shutdowns caused serious liquidity and revenue problems for many industries. In prior crises, these industries had to deal with the loss of a large percentage of revenue which led to layoffs and other financial issues. Covid-19 shutdowns introduced a scenario where revenue could be cut to zero. A large number of industries had to make up for nonexistent revenues on their balance sheets. This liquidity crisis hit the corporate bond market and created enough issues that the Fed had to step in to aid the credit crunch. While all industries were affected in some way, there were obvious targets that the pandemic affected to a greater extent. Among these include the travel, tourism, and hospitality sectors. Industries within these categories could be characterized as being highly affected by Covid-19. It's clear that the revenue for companies in these industries dried up, but what about their suppliers? If these industries had to completely shut down, there might be a ripple effect that hits the suppliers who have lost part of their customer base. Looking at the credit spreads on the corporate bonds of these suppliers as compared to the frontline industries they support over the Covid period could provide insight on a ripple effect that Covid has on the supply chain. While the financial crisis caused by the Covid-19 outbreak in 2020 has been researched well, the interaction between the Covid periods and the financial effect on hard-hit industries versus suppliers has not. This paper aims to look at this effect and discuss potential implications when looking at the policymaking performed by the Fed during the Covid-19 pandemic.

After identifying three key highly affected industries to be the frontline for this dataset, their supplier make-up and information can be collected and categorized. This paper selects air

transportation, accommodation, and full-service restaurants as the frontline industries for this model. Their top suppliers are gathered and ranked, and then the associated publicly traded companies within these industries were input into a database to collect all information on their corporate bonds from January 1st through December 31st of 2020. Their credit spreads were calculated using the associated Treasury yields for each date and this will be treated as the dependent variable. Independent variables consist mostly of indicator variables that show frontline industry, post-Covid, the post-Fed announcement of aid, and ranking of the supplier within each frontline industry. The interaction variables between the two event variables of post-Covid and post-Fed announcement with the industry category indicator variables will be created as well. These indicators, interaction variables, and a few controls are run through a few different simple linear regressions to examine their effects on credit spreads of corporate bonds. The results show a positive effect on credit spread associated with being a frontline industry bond post-Covid and a negative effect on credit spread associated with their suppliers post-Covid. This result shows the disproportionate effect Covid-19 has on industries, and more importantly that being a supplier to a frontline industry affected by Covid-19 shields you somewhat from the effects observed on the industry you supply. Another set of regression shows that being a frontline industry post-Fed announcement has a negative effect on credit spread but no discernable pattern for suppliers to these industries post-Fed announcement on credit spreads. The potential implications of this could be explored with future research and may provide explanation of the Federal Reserve's criteria for aid. That aside, the main goal of this paper is to highlight the disparity between the effect Covid has on different industries, specifically those highly affected and their suppliers by looking at the effects on credit spreads.

2. Literature

This paper outlines a comprehensive overview of the corporate bond market and Covid-19's effects on the selected frontline industries to demonstrate where this paper fits into research. This section is composed of two subsections: (1) an overview of the corporate bond market and Covid-19's effect on it and (2) Covid-19's effects on frontline industries.

2.1 An Overview of the Corporate Bond Market

First, it is important to analyze research on the background of the corporate bond market. Corporate bonds are categorized by investment grade or high-yield (junk) bonds. Investment grade bonds have a higher credit rating and a lower yield than junk bonds. Junk bonds are riskier due to their lower credit rating, so to make up for this they have a higher yield. Looking first at the Covid-19 effect on the bond market one can see the main issue in this market was liquidity that was remedied through intervention by the Fed.

The corporate bond market is about $8.8 trillion (O'Hara, Zhou 49). Investment-grade bonds' average daily trading volumes total $22.1 billion and high-yield bonds' average daily trading volumes total $7.8 billion for 2019 (O'Hara, Zhou 49). Corporate bond trading typically occurs in an over-the-counter dealer market and is primarily held by institutional investors that make up the large trade sizes. In Quarter 1 of 2020, six-hundred dealers intermediated trading with the largest ten taking control of 70% of the volume (O'Hara, Zhou 49). The liquidity crisis in the corporate bond market following Covid-19 began in early March as the bond market faltered with yields soaring and liquidity drying up. Transaction costs rose sharply while customer-to-dealer trades and customer-to-customer trade sizes decreased showing that the

market was unable to provide liquidity on its own. There were greater outflows for fixed-income funds, vulnerable or illiquid mutual funds, and those invested in highly affected industries. *Figure 1* shows the movements in ICE Bank of America option-adjusted yield spreads for investment-grade and high-yield bonds throughout the crisis period and *Table 1* outlines a timeline of macro-policies obtained through the Federal Reserve Bank of St. Louis (O'Hara, Zhou 50).

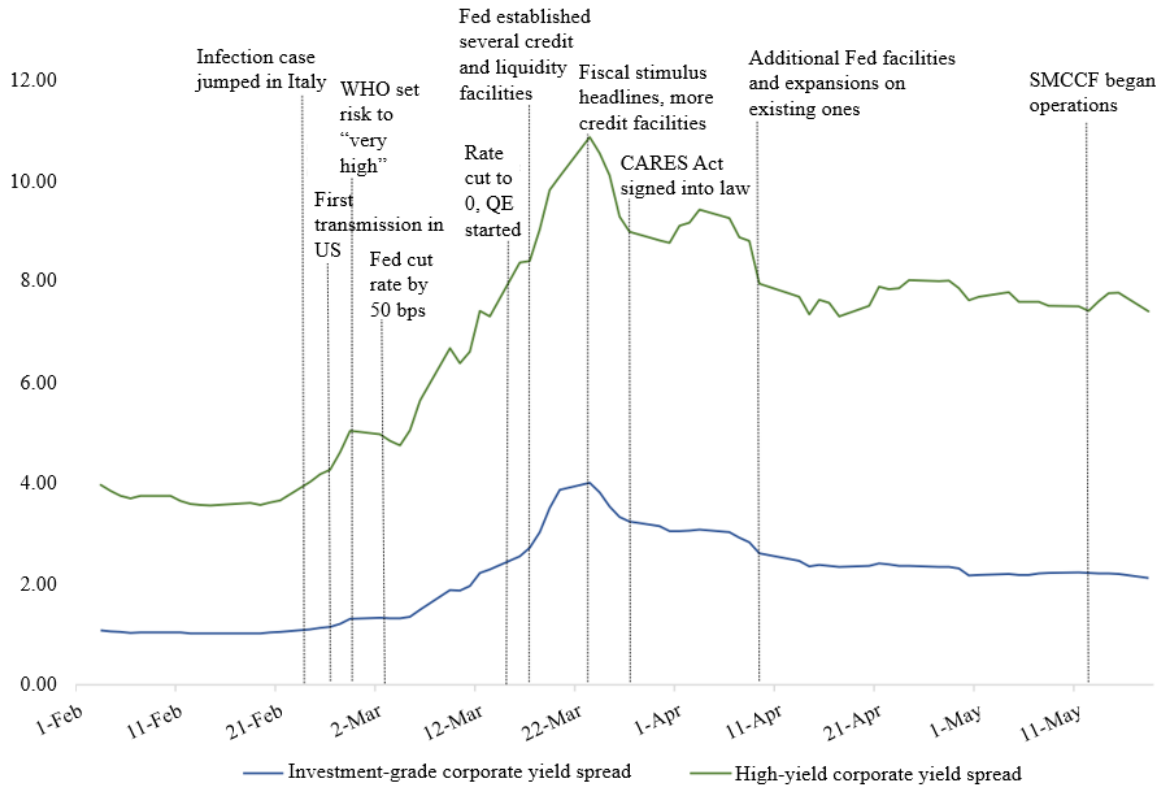

Figure 1: Yield spread movements. Data was obtained through the Federal Reserve Bank of St. Louis, Missouri. Adapted from "The electronic evolution of corporate bond dealers" by Maureen O'Hara and Xing Zhou, 2020. *2*, Vol. 142 p. 50.

Table 1: Covid-19 Key Events Timeline	
Date	
24-Feb	Covid cases in Italy jumped to more than two hundred from just a couple of days ago
26-Feb	Centers for Disease Control and Prevention (CDC) confirmed first possible community transmission of coronavirus in the US
28-Feb	World Health Organization (WHO) raised coronavirus threat assessment to its highest level
3-Mar	In response to the rapidly spreading virus, the Federal Open Market Committee (FOMC) made an emergency rate cut by half a percentage point, the biggest single cut since 2008 (On the same day, the G-7 released a statement that it would take action to help the global economy meet the threat of coronavirus)
15-Mar	Federal Open Market Committee (FOMC) cut the federal funds rate by a full percentage point to the effective zero bound. In addition, the Fed relaunced emergency measures from the 2007-2009 financial crisis, including restarting the quantitative easing (QE) program that would require $700 billion worth of asset purchaes for Treasuries and mortgage-backed securities (MBSs)
17-Mar	The Fed launched a number of credit an dliquidity facilities, including the Commercial Paper Funding Facility (CPFF), the Primary Dealer Credit Facility (PDCF) and the Money Market Mutual Fund Liquidity Facility (MMLF). (Date also covers the events that ocurred between the market close on Marhc 17th and market open on March 18th)
23-Mar	FOMC announced that the Fed is committed to purchasing Treasury securities and agency MBSs "in the amounts needed." In addition, the Fed launched three new credit facilities to firther mitigate the stress caused by the COVID-19 crisis: the Primary Market Corporate Crdit Facility (PMCCF), the Secondary Market Corporate Credit Facility (SMCCF), and the Term Asset-Backed Securities Loan Facility (TALF). On the same day, Treasury secretary Steven Mnuchin told CNBC that Democrats and Republicans are nearly in agreement on a congressional stimulus package
27-Mar	A $2 trillion coronavirus economic stimulus bill, the Coronavirus Aid, Relief, and Economic Security (CARES) Act, was cleared by Congress and signed into law by President Donald Trump
9-Apr	The Fed established four new facilities: the Municipal Liquidity Facility (MLF), the Main Street New Loan Facility (MSNLF), the Main Street Expanded Loan Facility (MSELF), and the Paycheck Protection Program Lending Facility (PPPLF). In addition, the Fed expanded the size and scope of the three existing facilities: PMCCF, SMCCF, and TALF. Together, the addditional credit provided through these facilities totals $2.3 trillion
12-May	SMCCF began purchases of exchanged-traded funds (ETFs)

Table 1: Covid-19 timeline and crisis macro policy responses. Data was obtained through the Federal Reserve Bank of St. Louis, Missouri. Adapted from "The electronic evolution of corporate bond dealers" by Maureen O'Hara and Xing Zhou, 2020. *Journal of Financial Economics*, Vol. 142 p. 50.

The issue was a credit crunch with "no market maker with both knowledges" (O'Hara, Zhou 2021) of buying and selling. To remedy this, the Federal Reserve stepped in. The Fed provided two waves of relief, the first being the Primary Dealer Credit Facility (PDCF) announced March 17th, and the second being the Secondary Corporate Credit Facility (SMCCF) announced March 23rd (O'Hara, Zhou 47). The PDCF was meant to enhance funding conditions for dealers and applied mostly to investment-grade bonds. The SMCCF was an agreement for the Fed to repurchase bonds to rebalance order flows in cases of excessive selling. There was a clear crisis in the corporate bond market which the Fed needed to step in to remedy. Among these more susceptible bonds were those in highly affected industries. The effects on the highly affected industries air transportation, accommodation, and restaurants during the 2020 Covid-19 period are detailed below.

2.2 Covid-19's Effects on Frontline Industries

Research highlights the extensive issues the accommodation, air transportation, and restaurant industries faced during the peak of the Covid-19 pandemic during 2020.

Lodging and accommodation dealt with immediate financial issues. In general, tourism was down which affects accommodation, airlines, and restaurants. Using economic data from prior disease epidemic and pandemic periods, a large pandemic similar to Covid-19 could cause a decrease in 10 million tourist arrivals which would lead to a decrease of around 2.4 million jobs in tourism and associated sectors (Skare, Soriano, Prada-Rochon 6). Even though in other cases, negative effects slow in the second year, this doesn't mean normality will be achieved. In 2020, there was a predicted recovery of five years. From 2019 to 2020, hotel room occupancy dropped from 66% to 44% and room revenue dropped from $167 billion to $85 billion (American

Hospitality and Lodging 6-7). According to the Bureau of Labor Statistics, in December of 2020, the unemployment rate for the accommodation sector was 18.9% (American Hospitality and Lodging Association 4). Empty rooms clearly led to unemployment, demonstrating a financial struggle for the accommodation industry. The hospitality sector itself anticipated a bleak and slow recovery based on the dismal numbers following 2020.

Air transportation saw similar damage. There was a decrease in passenger demand and country-wide bans. Fleets were grounded and runways were taken over to serve as parking lots for planes. US and global flight changes year over year are listed in *Figure 2*. There is an observable and steep decrease following March of 2020.

Table 2: US and Global Flight Changes YoY		
	United States	Total
January	2.70%	1.50%
February	2.10%	-7.80%
March	0.40%	-14.50%
April	-57.80%	-65.90%
May	-72.60%	-68.90%
June	-66.70%	-64.10%
July	-51.10%	-53.80%
August	-47.70%	-48.30%
September	-47.40%	-47.50%
October	-47.40%	-46.40%
November	-42.50%	-46.00%

Table 2: US and global flight changes year-over-year. Adapted from "COVID-19 pandemic and air transportation: Successfully navigating the paper hurricane" by Xiaoqian Sun, Sebastian Wandelt, Changhong Zheng, Anming Zhan, 2021, *Journal of Air Transportation* Vol. 94, p. 2.

Furthermore, the halt of aircraft manufacturing and restriction of aviation sector workers provided another issue. Flights remained reduced throughout the pandemic and the public viewed air transportation as a haven for and transmitter of disease, especially in the context of

prior disease outbreaks like SARS and Ebola. Financially, airlines are known to have a high cost of capital and the typical airline has the cash to cover only around two months of lost revenue (Sun, Wandelt, Zhang 7). Typically, some private investors might be willing to bail these companies out, but the increase in risk aversion following the financial crash caused by Covid-19 coupled with the uncertainty around the future of the air transportation industry removed these investors leaving the government as the main lifeline for airlines. The overall trend for the air transportation industry was down severely, showing its status as a hard-hit industry of Covid-19.

The restaurant and hospitality sector experienced massive shutdowns and issues as well. Shutdowns and social distancing made eating out impossible. Dining rooms in restaurants were nonfunctional. *Figure 2* shows analysis of the Open Table application's ability to track year-over-year reservations.

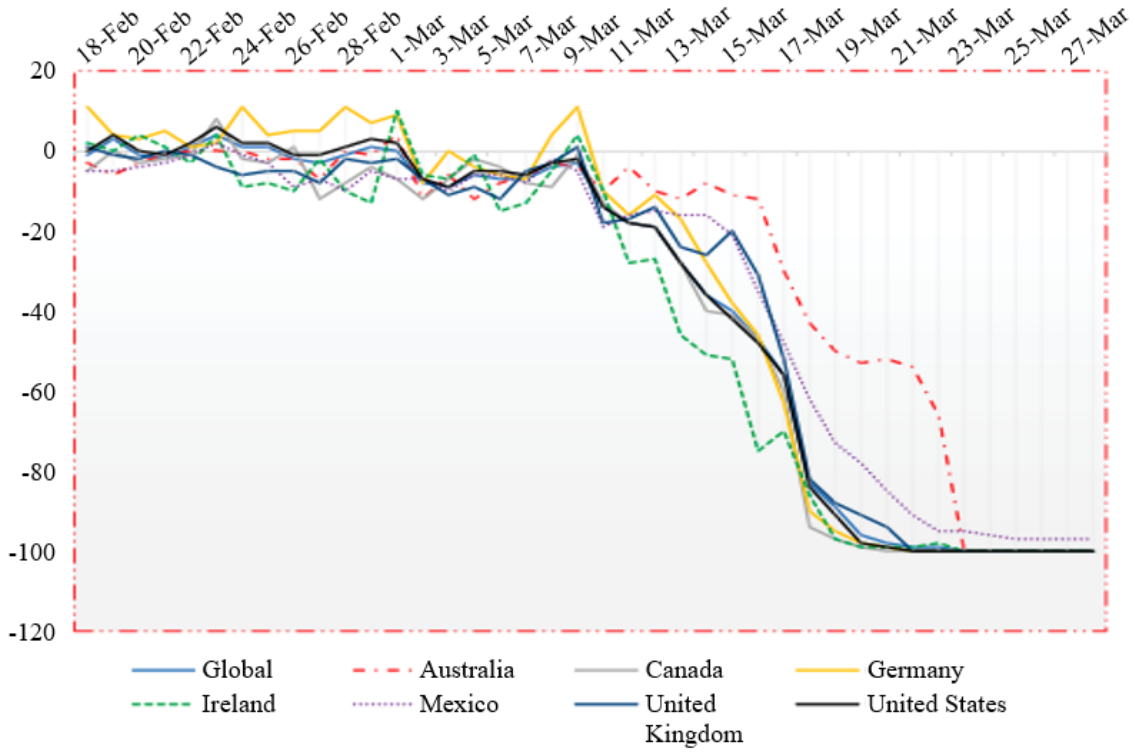

Figure 2: OpenTable reservation changes year-over-year. Adapted from "Covid-19 cripples global restaurant and hospitality industry" by Kaitano Dube, Godwell Nhamo, David Chikodzi, 2020. *Current Issues in Tourism* Vol. 24, p. 1488. Copyright 2020 by OpenTable.

There is a clear drop for all countries around early March 2020 to flatline near -100% towards the end of March. This was understandable due to strict lockdown in states like Washington, California, and New York from March 19th through March 25th in 2020 (Dube, Nhamo, Chikodzi 1488). By May 15th, half of US states had a ban on dine-in leading to a huge liquidity crisis despite the possibility of drive-thru and take-out (Dube, Nhamo, Chikodzi 1488). With no indoor dining, revenue was either completely lost or deeply slashed. Restaurants had a difficult time with the Covid-19 precautions. It is clear why industries like these would be so affected and the current research supports why.

Covid-19 created massive consequences across industries and in financial markets. The corporate bond market is a debt source for companies and it saw extensive damage. The Fed needed to step in and provide aid to these companies to smooth the spikes in credit spreads and loss of liquidity. When levying out aid, the Fed needs to know which industries are most affected. This research shows the highly affected industries included accommodation, air transportation, and restaurants. What does this mean for their suppliers? Being that close in proximity to such a defeated industry should mean expected damage down the supply chain, however, my regressions and results do not show this. In fact, the opposite effect is observed. In the next section, I will explain the data-collection method and follow up with the regressions run.

3. Data

The data section is comprised of two subsections: (1) data collection and (2) variable description.

3.1 Data Collection

The purpose of this analysis is to look at the effects Covid-19 has on the credit spreads of frontline industries versus their supplier industries. From the analysis of current literature, there is a lot of discussion regarding industries affected by Covid-19 but there's no lens that looks at the effect on their suppliers. Using a number of databases, I constructed a dataset to compare the credit spreads of a few key hard-hit industries and their suppliers. Controls were set for firm size and leverage, and dummy variables were utilized to create indicators for frontline industry, position in the supply chain, and to highlight two key financial events for 2020. The first step was to filter for the suppliers associated with each of the three highly-affected industries that are accommodation, air transportation, and full-service restaurants.

Table 3: Frontline Suppliers Breakdown			
		NAICS Code	Makeup
Accommodation			
1	Other real estate	531ORE	9.61%
2	Other financial investment activities	523900	4.31%
3	Monetary authorities and depository credit intermediation	52A000	4.30%
4	Offices of physicians	621100	3.76%
5	Nondepository credit intermediation and related activities	522A00	3.61%
6	Data processing, hosting, and related services	518200	3.56%
7	Legal services	541100	3.13%
8	Employment services	561300	3.13%
9	Federal general government (defense)	S00500	2.92%
10	State and local government other services	N/A	2.89%
Air Transportation			
1	Federal general government (defense)	S00500	9.67%
2	Other real estate	531ORE	7.89%
3	Other financial investment activities	523900	4.33%
4	Federal general government (nondefense)	S00600	3.59%
5	Monetary authorities and depository credit intermediation	52A000	2.95%
6	Motor vehicle and motor vehicle parts and supplies	423100	2.91%
7	State and local government other services	N/A	2.84%
8	Offices of physicians	621100	2.49%
9	Nondepository credit intermediation and related activities	522A00	2.48%
10	Legal services	541100	2.05%
Full-service Restaurants			
1	Other real estate	531ORE	16.74%
2	Hospitals	622000	10.02%
3	Offices of physicians	621100	5.60%
4	Monetary authorities and depository credit intermediation	52A000	4.78%
5	Architectural, engineering, and related services	541300	3.32%
6	Legal services	541100	2.75%
7	Other financial investment activities	523900	2.63%
8	Nondepository credit intermediation and related activities	522A00	2.30%
9	Data processing, hosting, and related services	518200	2.27%
10	Electric power generation, transmission, and distribution	221100	2.17%

Table 3: Top 10 suppliers from the accommodation, air transportation, and full-service restaurants. Data sourced from Input-Output Tables by Bureau of Economic Analysis, 2012.

To get my data, I started by utilizing the 2012 Make-and-Use Tables compiled by the Bureau of Economic Analysis. These tables total up the dollar amounts that industries supply to each other. The data used comes from 2012 as this is the most recent set of data the Bureau has published. The industries I picked to analyze are based on my research of industries highly

affected by Covid-19 and these were, accommodation, air transportation, and full-service restaurants. Each supplier had their total dollar amount contribution recorded as a percentage out of the intermediate total for each of the three industries chosen. The intermediate total adds up all dollar amounts supplied to the industry before expenditures and taxes. The top ten industries are recorded *Table 3*. Some of these industries were omitted despite being included in the top ten. Government industries were omitted as I am looking at corporate bonds so they do not apply. Financial institutions which are marked with NAICS codes beginning with "52" were also omitted to avoid skewing the data. Examining dataset size, including financial institution industries would have made up more than 50% of the dataset. While this leaves a smaller number of industries to categorize left over, no other industries were considered to avoid complicating or skewing the data outside the top ten contributors. This could be a potential opportunity for future research.

3.2 Variable Description

Once these industries were identified, the next step was to filter through the Center for Research in Security Prices (CRSP) database on Wharton Research Data Services (WRDS) to find the corresponding tickers to plug into Trading Reporting and Compliance Engine database (TRACE.) The CRSP database collects security price, return, and volume data for the NYSE, AMEX, and NASDAQ stock markets. After the tickers for the correct industries were gathered, they were input into TRACE to get data on bonds for these companies from the year 2020. TRACE tracks bond characteristics from bond transactions. From there, the corresponding T-yields for each date from the Federal Reserve Economic Data St. Louis database (FRED) were subtracted as the risk-free rate to create the credit spreads. To be specific, I used the daily market

yield on U.S. Treasury Securities at a 10-year constant maturity. I added in total assets and long-term debt information by the company to create a control for firm size and leverage using the North American Annual Fundamentals under the Compustat-Capital IQ database within WRDS. The period for the full set of data goes from January 1, 2020 through December 21, 2020 to capture the pre-Covid period as well as the pandemic itself. Table A.1 in the appendix details the list of variables and their definitions.

The dependent variable used in all regressions is "credit spread" which is the natural log of the calculated credit spread plus one to ensure missing observations are not omitted. Most of the variables are dummy variables or interaction variables to chronicle the change in credit spreads associated with the category of industry and important financial events. Each of the three highly affected industries is identified as the "frontline" variable. The ranking of the suppliers is categorized with "top" representing industries within the top three of suppliers, "middle" representing industries within the middle three, and "low" representing industries within the bottom four of each respective frontline industry. The two financial events examined are Post-Covid and Post-Fed Announcements. Post-Covid is represented by "postCovid" and it refers to transactions occurring after the start of the pandemic. February 20, 2020 was selected as the date because this was recorded as the start of the financial crisis associated with Covid-19 (Frazier 1). Post-Fed Announcement is represented as "postFed" and this indicates bond transactions occurring on March 24th, 2020. This date was selected to examine the immediate impact of both announcements made by the Fed to aid the corporate bond market. The first was made on March 17th and the second was on March 23rd (O'Hara, Zhou 47). The controls are "total assets" to describe the natural log of the total assets and "debt to assets" to describe the

ratio of long-term debt over assets. These represent firm size and leverage respectively, and they were pulled from the Compustat Financial Annual Fundamentals. Now that the important variables have been identified, the next step is to explain the process of linear regressions to look at the effects these variables have on the independent variable, credit spread.

4. Methods

The Methods section is composed of two subsections: (1) hypothesis and (2) regressions.

4.1 Hypothesis

Past research demonstrates a clear impact on industries that were widely affected by the shutdowns caused by the Covid-19 pandemic. Financial markets as a whole struggled and the Federal Reserve was forced to step in to deal with unprecedented issues in the corporate bond market. It's important to recognize which industries were widely affected as there could be a potential ripple down the supply chain that is cause for concern. However, there isn't a guarantee that this will be observed. Financial markets as a whole suffered but there likely is a disproportionate effect stemming from key industries which need more focus than those less affected. The shield effect observed is one where suppliers of hard-hit industries are less affected than hard-hit industries themselves. Specifically, I hypothesize that frontline industries have a widening of credit spreads on corporate bonds post-Covid while their suppliers see a lessened effect on their associated credit spreads. These results from this hypothesis would show that some industries need more aid than others when it comes to policy-making and financial support.

4.2 Regressions

There were a few regressions run to explore my hypothesis. I will lay out the baseline regressions that will provide the foundation for the subsequent final regressions which explore the effect on the supply chains of my selected frontline industries. One thing to note for each

regression run is the way they were input into Stata. Each of the following regressions run used robust standard errors. Dummy variables were also calculated by month and by NAICS code with one of each filtered out naturally to avoid collinearity. To avoid confusion, these dummy variables will be labeled as "i.month" and "i.naicscode" respectively in the regression equations and omitted from the results tables.

The first regression, Equation (1) deals with the interaction between the post-Covid variable and the frontline variable on credit spread.

$$credit\ spread = a_0 + B_1 postCovid\ frontline + B_2 frontline +$$
$$B_3 postCovid + B_4 total\ assets + B_5 debt\ to\ assets + i.month$$
$$+ i.naicscode + \varepsilon \quad (1)$$

The next baseline regression, Equation (2) deals with the effects of the Fed announcement overall on credit spread. This regression is restricted to the bond transactions between March 20th and March 24th to illuminate the immediate effect the Fed's announcement had on credit spreads.

$$credit\ spread = a_0 + B_1 postFed\ announcement + B_2 frontline$$
$$+ B_3 postCovid + B_4 total\ assets + B_5 debt\ to\ assets$$
$$+ i.month + i.naicscode + \varepsilon \quad (2)$$

The equation deals with the interaction between each frontline industry's top, middle, and bottom suppliers with the post-Covid period. The first regression, Equation (3), shows accommodation and omits the low category to avoid collinearity.

$$credit\ spread = a_0 + B_1\ postCovid\ top\ accommodation$$
$$+B_2 postCovid\ middle\ accommodation + B_3 frontline + B_4 postCovid$$
$$+B_5 total\ assets + B_6 debt\ to\ assets + i.month + i.naicscode + \varepsilon$$

(3)

The next regression, Equation (4), shows air transportation and omits low once again to avoid collinearity.

$$credit\ spread = a_0 + B_1 postCovid\ top\ air\ transportation$$
$$+B_2 postCovid\ middle\ air\ transportation + B_3 frontline + B_4 postCovid$$
$$+B_5 total\ assets + B_6 debt\ to\ assets + i.month + i.naicscode + \varepsilon$$

(4)

The final regression, Equation (5), in the post-Covid effect section shows full-service restaurants and omits the middle category.

$$credit\ spread = a_0 + B_1 postCovid\ top\ restaurants$$
$$+B_2 postCovid\ low\ restuarants + B_3 frontline + B_4 postCovid$$
$$+B_5 total\ assets + B_6 debt\ to\ assets + i.month + i.naicscode + \varepsilon$$

(5)

The next set of final regressions is once again broken up by frontline industry and outlines the interaction between these industries' suppliers and the Federal Reserve's second announcement of aid. Similarly, to the baseline regression, these regressions are also limited to the transactions occurring on and between March 20th and March 24th to observe the immediate effect of the announcement on credit spreads. The regression for each frontline industry utilizes the same rankings as used above to achieve consistency, which means top and mid are used for accommodation and air transportation, while top and low are used for full-service restaurants. Below is accommodation's regression, Equation (6), for the interaction of its ranked suppliers with the Fed's announcement on credit spread.

$$credit\ spread = a_0 + B_1 postFed\ top\ acccommodation$$
$$+B_2 postFed\ middle\ accommodation + B_3 postCovid\ top\ accommodation$$
$$+B_4 postCovid\ middle\ accommodation + B_5 frontline + B_6 postFed$$
$$+B_7 postCovid + B_8 total\ assets + B_9 debt\ to\ assets + i.month$$
$$+i.naicscode + \varepsilon \quad (6)$$

Next is the regression, Equation (7), for the interaction between air transportation's ranked industries and the Fed's announcement and its effect on credit spread.

$$credit\ spread = a_0 + B_1 postFed\ top\ air\ transportation$$

$$+B_2 postFed\ middle\ air\ transportation$$

$$+B_3 postCovid\ top\ air\ transportation$$

$$+B_4 postCovid\ middle\ air\ transportation + B_5 frontline + B_6 postFed$$

$$+B_7 postCovid + B_8 total\ assets + B_9 debt\ to\ assets + i.month$$

$$+i.naicscode + \varepsilon$$

(7)

Finally, the regression, Equation (8), shows the interaction between full-service restaurant suppliers and the Fed's announcement on credit spreads.

$$credit\ spread = a_0 + B_1 postFed\ top\ restaurants$$

$$+B_2 postFed\ low\ restaurants + B_3 postCovid\ top\ restaurants$$

$$+B_4 postCovid\ low\ restaurants + B_5 frontline + B_6 postFed$$

$$+B_7 postCovid + B_8 total\ assets + B_9 debt\ to\ assets + i.month$$

$$+i.naicscode + \varepsilon$$

(8)

Now that each equation has been laid out, I will analyze the results from running these regressions through Stata.

5. Results

Below are the results for a total of eight regressions. The results section will be split into four subsections: (1) baseline regressions, (2) interaction between ranked suppliers and post-Covid, (3) interaction between ranked suppliers and the Fed announcement, and (4) implications on future research policy-making. With these regressions, it is important to note that variables having a positive effect on credit spread means that credit spread widens which is not good for the companies that issued those bonds. Conversely, a negative effect on credit spread means that credit spread is shrinking which is a good thing for the companies who issued those bonds.

5.1 Baseline Regressions

The following baseline regressions will provide the foundation for the next two subsections. It is important to note that every variable in the following two baseline regressions is statistically significant.

Table 4: Post-Covid and Frontline Baseline Regression

	Coefficient	Std. Error	T-value	P > |t|
Independent Variables				
postCovid frontline	0.286	0.004	66.32	0.000
frontline	0.760	0.004	169.09	0.000
postCovid	0.087	0.004	23.00	0.000
Control Variables				
total assets	-0.194	0.001	-324.44	0.000
debt to assets	-0.624	-0.005	-116.86	0.000
Intercept	2.888	0.008	349.44	0.000
R squared	37.85%			

The key variable in *Table 4* is "postCovid frontline" which represents the interaction between the two variables below which are "frontline" and "postCovid." The variable "postCovid frontline" has a statistically significant and positive effect on credit spread which means frontline industry bonds tracked post-Covid are associated with an increase in credit spread of 0.29%. Furthermore, bonds in frontline industries have a statistically significant and positive effect on credit spread which means frontline industries are associated with a widening of credit spreads of 0.76%. In general, bonds tracked post-Covid have a statistically significant and positive effect on credit spread as well, which also implies that post-Covid bonds are associated with an increasing of credit spreads of 0.09%. Looking at the controls, both total assets and debt-to-assets have an associated statistically significant and negative effect on credit spread. Increasing total assets by one million dollars is associated with a decrease in credit spread of 0.19% and increasing the debt-to-assets ratio by 0.01 is associated with a decrease in credit spread of 0.01%. The controls make sense because more assets are a sign of financial stability which would be associated with a lower credit spread, and the debt-to-asset ratio has a very small negative effect on credit spread. The effect "frontline," "postCovid," "total assets," and "debt to assets" will be displayed in each of the following seven regressions as well with the same sign on the coefficients.

Table 5: Post-Federal Reserve Announcements				
	Coefficient	Std. Error	T-value	P > |t|
Independent Variables				
postFed frontline	-0.085	0.013	-6.650	0.000
postFed	-0.120	0.006	-19.56	0.000
frontline	0.644	0.011	57.41	0.000
Control Variables				
total assets	-0.119	0.004	-33.57	0.000
debt to assets	-0.456	0.029	-15.92	0.000
Intercept	3.112	0.045	69.43	0.000
R squared	47.84%			

In *Table 5*, the variable "postCovid" was omitted. This is likely because the dates for "postCovid" and "postFed" are very close to one another which could cause collinearity. The variable "postFed" has a statistically significant and negative effect on credit spread which means bonds recorded the day after the Fed's second announcement offering support to the corporate bond market are associated with a decrease of credit spreads of 0.12%. The variable "postFed frontline" has a statistically significant and negative spread on credit spread as well which means frontline industry bonds recorded the day after the Fed's second announcement are associated with a decrease of 0.09% in credit spread. In the next two subsections, I will discuss the regressions that deal with the ranked suppliers of frontline industries and their interactions with the two events outlined in this first subsection.

5.2 Interaction Between Ranked Suppliers and Post-Covid Regressions

Each of the following regressions deals with the three ranked categories for each frontline industry and their interactions with the post-Covid variable. To clarify, one category for the ranked suppliers is omitted to avoid collinearity. All variables for the following three regressions are statistically significant.

Table 6: Accomodation Suppliers Post-Covid				
	Coefficient	Std. Error	T-value	P > |t|
Independent Variables				
postCovid top accommodation	-0.151	0.002	-72.62	0.000
postCovid middle accommodation	-0.297	0.004	-69.13	0.000
frontline	1.022	0.002	481.88	0.000
postCovid	0.197	0.006	-319.71	0.000
Control Variables				
total assets	-0.192	0.001	-319.71	0.000
debt to assets	-0.621	0.005	-116.23	0.000
Intercept	2.772	0.008	334.26	0.000
R squared	37.92%			

Table 6 shows the interaction between post-Covid and accommodation's top and middle categories. The variables "postCovid top accommodation" and "postCovid middle accommodation" both have statistically significant and negative effects on credit spread. This means that bonds in the top and middle categories of accommodation suppliers recorded post-Covid have an associated effect of decreasing credit spreads by 0.15% and 0.30% respectively. Compared to the baseline regressions looking at frontline industry bonds' interactions with post-Covid that were statistically significant and positive, the difference in effect on credit spread between the frontline industry of accommodation and its suppliers is clear.

Table 7: Air Transportation Suppliers Post-Covid				
	Coefficient	Std. Error	T-value	P > |t|
Independent Variables				
postCovid top air transportation	-0.141	0.002	-67.66	0.000
postCovid mid air transportation	-0.240	0.010	-24.20	0.000
frontline	1.024	0.002	482.15	0.000
postCovid	0.178	0.004	47.29	0.000
Control Variables				
total assets	-0.192	0.001	-320.02	0.000
debt to assets	-0.621	0.005	-116.31	0.000
Intercept	2.789	0.008	336.83	0.000
R squared	37.85%			

Table 7 shows the interaction between post-Covid and air transportation's top and middle categories. The variables "postCovid top air transportation" and "postCovid middle air transportation" both have statistically significant and negative effects on credit spread. This means that bonds in the top and middle categories of air transportation suppliers recorded post-Covid have an associated effect of decreasing credit spreads by 0.14% and 0.24% respectively. Again, looking back and comparing to the frontline post-Covid interaction variable in the baseline regression that was statistically significant and positive, there is a clear difference between the frontline industry of air transportation and its suppliers.

Table 8: Full-service Restaurants Suppliers Post-Covid				
	Coefficient	Std. Error	T-value	P > |t|
Independent Variables				
postCovid top restaurants	-0.305	0.003	-90.24	0.000
postCovid low restaurants	-0.346	0.002	-162.61	0.000
frontline	0.708	0.003	250.78	0.000
postCovid	0.395	0.004	96.64	0.000
Control Variables				
total assets	-0.192	0.001	-317.30	0.000
debt to assets	-0.619	0.005	-115.33	0.000
Intercept	1.891	0.008	346.47	0.000
R squared	38.41%			

Finally, *Table 8* looks at the interaction between post-Covid and full-service restaurants' top and low categories. The variables "postCovid top restaurants" and "postCovid low restaurants" both have statistically significant and negative effects on credit spread. This means that bonds in the top and bottom categories of full-service restaurant suppliers recorded post-Covid have an associated effect of decreasing credit spreads by 0.31% and 0.35% respectively. This is the third frontline industry to demonstrate the disparity between effects post-Covid on credit spreads compared to their suppliers. The implications of this will be discussed in the fourth section of the results. First, I examine the results when looking at the interaction of these suppliers with the Fed's announcement.

5.3 Interaction Between Ranked Suppliers and the Fed's Announcement Regressions

The following set of regressions examines how the ranked suppliers' interaction with the Fed announcement variable affected credit spread. One category of ranked supplier is omitted to avoid collinearity and matches the corresponding omitted category from the regressions for

each frontline industry's supplier in the previous section. All variables in the following three regressions are statistically significant.

Table 9: Accommodation Suppliers Post-Fed Announcement				
	Coefficient	Std. Error	T-value	P > |t|
Independent Variables				
postFed top accommodation	-0.029	0.013	-2.30	0.022
postFed middle accommodation	0.057	0.017	3.45	0.001
postCovid top accommodation	-0.151	0.002	-79.39	0.000
postCovid middle accommodation	-0.298	0.004	-69.16	0.000
frontline	1.023	0.002	482.94	0.000
postFed	0.322	0.005	66.40	0.000
postCovid	0.197	0.008	51.90	0.000
Control Variables				
total assets	-0.192	0.001	-319.84	0.000
debt to assets	-0.620	0.005	-116.17	0.000
Intercept	2.772	0.008	334.32	0.000
R squared	38.00%			

Table 9 shows the interaction between the post-Fed announcement variable and accommodation's top and middle categories. The variable "postFed top accommodation" has a statistically significant and negative effect but "postFed middle accommodation" has a statistically significant and positive effect on credit spread. This means that bonds in the top category of accommodation suppliers recorded the day after the Fed announcement have an associated effect of decreasing credit spreads by 0.03%, however, bonds in the middle category have the associated effect of increasing credit spread by 0.06%. Comparing this to the baseline regression looking at frontline industry bonds' interactions with the post-Fed announcement that were statistically significant and negative, we see that the top suppliers behave similarly to their frontline industry but the middle suppliers do not.

Table 10: Air Transportation Suppliers Post-Fed Announcement				
	Coefficient	Std. Error	T-value	P > |t|
Independent Variables				
postFed top air transportation	-0.034	0.013	-2.69	0.007
postFed middle air transportation	-0.068	0.026	-2.62	0.009
postCovid top air transportation	-0.140	0.002	-67.43	0.000
postCovid mid air transportation	-0.239	0.010	-24.09	0.000
frontline	1.025	0.002	483.23	0.000
postFed	0.327	0.005	69.67	0.000
postCovid	0.178	0.004	47.25	0.000
Control Variables				
total assets	-0.193	0.001	-320.16	0.000
debt to assets	-0.610	0.005	-116.26	0.000
Intercept	2.79	0.008	336.91	0.000
R squared	37.93%			

Table 10 shows the interaction between the post-Fed announcement variable and air transportation's top and middle categories. The variables "postFed top air transportation" and "postFed middle air transportation" both have statistically significant and negative effects on credit spread. This means that bonds in the top and middle categories of air transportation suppliers recorded the day after the Fed announcement have an associated effect of decreasing credit spreads by 0.03% and 0.07% respectively. When comparing to the baseline regression looking at frontline industry bonds' interactions with the post-Fed announcement that were statistically significant and negative, we see that the air transportation industry's suppliers are behaving similarly to air transportation itself as a frontline industry.

Table 11: Full-service Restaurants Suppliers Post-Fed Announcement				
	Coefficient	Std. Error	T-value	P > |t|
Independent Variables				
postFed top restaurants	-0.060	0.014	-4.24	0.000
postFed low restaurants	0.088	0.010	8.69	0.000
postCovid top restaurants	-0.305	0.003	-90.09	0.000
postCovid low restaurants	-0.347	0.002	-162.81	0.000
frontline	0.709	0.003	251.28	0.000
postFed	0.286	0.008	35.46	0.000
postCovid	0.396	0.004	96.66	0.000
Control Variables				
total assets	-0.192	0.001	-317.47	0.000
debt to assets	-0.680	0.005	-115.27	0.000
Intercept	2.892	0.008	346.56	0.000
R squared	38.50%			

Table 11 shows the interaction between the post-Fed announcement variable and full-service restaurant's top and bottom categories. Similarly to what we saw with accommodation, the variable "postFed top restaurants" has a statistically significant and negative effect but "postFed low restaurants" has a statistically significant and positive effect on credit spread implying that bonds in the top category of accommodation suppliers recorded the day after the Fed announcement have an associated effect of decreasing credit spreads by 0.06%, while bonds in the bottom category have the associated effect of increasing credit spreads by 0.09%. The baseline regression with frontline industry bonds' interactions with post-Fed announcement as statistically significant and negative, and we now see that the top suppliers behave similarly to their frontline industry, but the low suppliers do not. The next section will summarize these results and discuss implications of what they mean going forward with future research and potential impact on policymaking.

5.4 Implications on Future Research and Policy-Making

We now know that the frontline industries saw a statistically significant and positive effect on credit spreads post-Covid while their suppliers saw a statistically significant and negative effect. The implications of this show that certain industries are more affected than others and that this effect is not observed down the supply chain. What this means for policy-making is that since some industries see a disproportionate effect during a financial crisis like the one seen during the Covid-19 pandemic. These effects should be taken into consideration when providing aid.

My original hypothesis expected a lessening of Covid's impact on suppliers as compared to their frontline industries. Likely there would be some widening of credit spreads, but it would be less severe than the effect observed on frontline industries. In reality, my regressions showed an opposite effect where credit spreads for the suppliers decreased. The causes behind this might be observed in later research, but for now, the hypothesis that there will be a lessened effect is still proved, just to a further extent than expected. This is important because the proximity of those suppliers to hard-hit industries is likely considered when it comes down to providing aid. My regressions prove that the effect observed on frontline industries does not necessarily trickle down through the supply chain and this should be taken into account for future policymaking. The other event observed was the Fed's announcements and the effect this had on credit spreads across industries.

Looking at the second set of regressions, there wasn't a perfect pattern demonstrated. Accommodation and full-service restaurants saw their top suppliers have a statistically significant and negative effect on credit spreads the day after the Fed's announcement, while

the middle and bottom categories respectively saw the reverse. Air transportation, however, saw both the top and middle categories have a statistically significant and negative effect on credit spread the day after the Fed's announcement. What could this mean? There is an opportunity for more research here. The mixed effect on suppliers might be due to the Fed providing disproportionate aid, which is why certain suppliers did not see a statistically significant negative effect after their announcement. Looking into what factors the Fed considered when levying out aid would be helpful and could illuminate why the post-Covid interaction with these suppliers saw a pattern but the interaction with the Fed's intervention did not. Regardless, the finding that every regression saw all statistically significant variables gives a lot of information on the frontline industries versus their supply chain that is very applicable to future research and policymaking.

6. Conclusion

This paper works to discover a difference in credit spreads of corporate bonds between frontline industries and their suppliers following a financial crisis like a pandemic. By looking at 2020, the year Covid-19 flourished and financial markets struggled, different variables' effects on credit spreads illuminates a lot about the difference between the highly-affected industries and their supply chain.

The dataset showed three highly-affected or frontline industries and their top ten supplier industries. Using databases to track bond information for associated publicly traded companies within these industries, I created a dataset to examine the interaction between frontline industries versus their suppliers after two important events during the period using firm size and leverage as controls. The results demonstrated an increasing credit spread for frontline industries post-Covid and a decreasing credit spread for their suppliers. This demonstrates a lesser effect of Covid-19 on some industries despite their ties to highly-affected industries. Not only does this prove my hypothesis of a lessened effect of Covid on suppliers but it shows a reversal of Covid-19's effect as you move from the frontline to the supply chain. This highlights a disparity in the corporate bond market stability across industries and has implications for future policymaking especially because the Fed had to help out the corporate bond market amid the Covid-19 financial crisis.

The disproportionate effect between industries means some industries need more help than others. The Fed may have already figured this out which is why there is no discernable pattern when looking at the credit spreads between frontline industries versus their suppliers after the Fed's announcement regarding corporate bond bailouts. This explanation would be best suited

to future research. In conclusion, highly-affected, frontline industries as demonstrated through the selected industries of accommodation, air transportation, and full-service restaurants, are associated with widening credit spreads after the Covid-19 financial crisis hit while their suppliers are associated with decreasing credit spreads illuminating a clear disparity between Covid-19's negative financial effects on frontline industries versus their supply chain.

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A. Appendix

A.1 Table of Variable Definitions

Table A.1: Variable Definitions	
credit spread	ln(1 + credit spread)
postCovid	Dummy variable indicating if the bond was recorded after 02/20/2020
frontline	Dummy variable indicating if the bond belongs to one of the 3 frontline industries
postCovid frontline	Interaction variable between post-Covid and frontline
total assets	ln(total assets) to show company size
debt to assets	Long-term debt / total assets to show leverage
postFed	Dummy variable indicating if the bond was recorded on 03/24/2020
postFed fronline	Interaction variable between post-Fed announcement and frontline
top accommodation	Dummy variable indicating if the bond belongs to the top 3 suppliers of Accommodation
middle accommodation	Dummy variable indicating if the bond belongs to the middle 3 suppliers of Accommodation
low accommodation	Dummy variable indicating if the bond belongs to the bottom 4 suppliers of Accommodation
top air transportation	Dummy variable indicating if the bond belongs to the top 3 suppliers of Air Transportation
middle air transportation	Dummy variable indicating if the bond belongs to the middle 3 suppliers of Air Transportation
low air transportation	Dummy variable indicating if the bond belongs to the bottom 4 suppliers of Air Transportation
top restaurants	Dummy variable indicating if the bond belongs to the top 3 suppliers of Full-service Restaurants
middle restaurants	Dummy variable indicating if the bond belongs to the middle 3 suppliers of Ful-service Restaurants
low restuarants	Dummy variable indicating if the bond belongs to the bottom 4 suppliers of Full-service Restaurants
postCovid top accommodation	Interaction variable between post-Covid and top accommodation
postCovid middle accommodation	Interaction variable between post-Covid and middle accommodation
postCovid top air transportation	Interaction variable between post-Covid and top air transportation
postCovid middle air transportation	Interaction variable between post-Covid and middle air transportation
postCovid top restaurants	Interaction variable between post-Covid and top restaurants
postCovid low restuarants	Interaction variable between post-Covid and low restaurants
postFed top accommodation	Interaction variable between post-Fed announcement and top accommodation
postFed middle accommodation	Interaction variable between post-Fed announcement and middle accommodation
postFed top air transportation	Interaction variable between post-Fed announcement and top air transportation
postFed and middle air transportation	Interaction variable between post-Fed announcement and middle air tranportation
postFed top restaurants	Interaction variable between post-Fed announcement and top restaurants
postFed low restaurants	Interaction variable between post-Fed announcement and low restaurants