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The effect of the SMCCF announcement and purchase on eligible transportation sector bonds

Bethuel-Ange Yebouet

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The effect of the SMCCF announcement and purchase on eligible transportation sector bonds

Thesis Submitted to Levy Economics Institute of Bard College

by Bethuel-Ange Yebouet

Annandale-on-Hudson, New York, May 2022
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PLAGIARISM STATEMENT

I have written this project using my own words and ideas, except otherwise indicated. I have subsequently attributed each word, idea, figure, and table which is not my own to their respective authors. I am aware that paraphrasing is plagiarism unless the source is duly acknowledged. I understand that the incorporation of material from other works without acknowledgment will be treated as plagiarism. I have read and understood the Levy Economics Institute of Bard College's statement on plagiarism and academic honesty as well as the relevant pages in the Student Handbook.

Bethuel 05/13/2022
ABSTRACT

Covid highlighted the financial vulnerability of both small and large businesses in the U.S economy. In response, the Federal Reserve announced the creation of the secondary market corporate credit facilities (SMCCF) on March 23, 2020, with the aim of providing liquidity to US firms through bond financing. The goal was to build a portfolio of bonds that attempted to achieve a wide, diversified market index of US corporate bonds. When looking at the composition of the SMCCF broad market index and percentage (%) of par value from the federal reserve bank of New York, firms from the transportation sector received one of the lowest funding out of any other sector. The purpose of this thesis is to determine how the corporate bond announcements and eventual purchases aided the transportation sector’s bond spreads and default risk probability. My fixed effect panel data regression model indicates that the March 23rd announcements temporarily raised bond spreads for transportation sector companies, owing to their low credit bond ratings and initial ineligibility when the program was introduced. The SMCCF was expanded on April 9th, and lesser-rated bonds were made eligible, dramatically reducing spreads for transportation sector issuers, as some of the bonds had yields trading lower than the US treasury. The collapse of employment, travel restrictions, interminable shutdowns, and the ongoing epidemic all put a halt to the operations of certain transportation firms while enabling others to continue operating at a reduced capacity. A comparison of spreads within transportation sector companies that participated in the SMCCF reveals that firms that operated at some capacity and received the most credit facility funding (such as BNSF) traded at lower and more stable yields than firms whose line of business was completely shut down (like Delta airlines). The actual purchase of the bonds also aided the overall reduction of the spreads but not as much as the announcement effect. These results show that the Fed’s action was helpful in providing liquidity to the transportation sector of the CCF.

Keywords: Bond Spread; Corporate bond; Transportation sector; Secondary Market Corporate Credit facility; Broad market index

JEL Classification: G01, G32, G13, G33, E44, C41
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1 INTRODUCTION

Circumstances like the global pandemic led to disruptions of business activities across the U.S. This subsequently led to losses of revenue and profits for many firms. The quarantine and travel restrictions that were implemented during the height of the pandemic have led to a reduction of resource mobility, and consumer travel to reduce the spread of the virus. As a result, most companies in the transportation sector in the financial markets struggled to maintain their operational costs, sustain employee payroll, finance maturing debts, and obtain new forms of credit. This led to a greater number of defaults in debt obligations. To prevent defaulting, U.S companies at this time were forced to downsize, with budget cuts and layoffs. This environment will lead to a decrease in consumer confidence in the financial market with investors racing to sell their bonds or demand higher interest payments in order to make up for the firm’s higher probability of default. Should this unfortunate event happen at a massive scale with larger companies, then bigger calamities could occur with even greater job losses and larger operational constraints. In the event that investors may want to sell their bonds, they would most likely have a hard time finding buyers with enough confidence to buy them, all while shutdowns will have led to a loss of revenues by numerous firms. Investors would want to liquidate their corporate bonds due to the troubling climate. This is where the corporate credit facilities come into play. The federal government established the main market corporate credit facility to provide funds to US firms for the acquisition of newly and previously issued bonds, allowing them to continue functioning regularly in an unpredictable market. After a company has issued a bond, other investors can buy or sell the financial instrument on the secondary market. However, if businesses fail to meet their objectives and are unable to make interest payments on their bonds, their creditworthiness will deteriorate, and the amount of trading volume in the secondary market will decline. To prevent this from taking place the Federal Reserve provided liquidity to the secondary market corporate credit facility by purchasing U.S company bonds from investors within a portfolio, thereby keeping markets stable for both consumers and firms. Numerous monetary policies and funding mechanisms were implemented in the aftermath of the pandemic, although most of these included intermediaries. The Secondary Market corporate credit facility was the sole operation in which the Federal Reserve engaged as an investor, built
its own portfolio, and participated directly in the secondary bond market. The goal was to financially support the income stream of companies and to sustain employment, capital, supply chains, and any other form of resources that needed assistance. This in turn will lead to a healthier economy with more stability in the aggregate.

The Federal Reserve purchased existing corporate bonds from other investors in the secondary market, and newly issued corporate bonds in the primary market to help maintain the market for companies that need funding and investors that need to liquidate their assets. These purchase establishments were reported periodically on their website, and updates were made by the Board of Governors of the Federal Reserve System. The SMCCF didn't hold more than 10% of the bonds issued by a given corporation that met the criteria. Hence,

The SMCCF may purchase corporate bonds that meet each of the following criteria at the time of purchase: (i) issued by an eligible issuer; (ii) rated at least BBB-/Baa3 by a major nationally recognized statistical rating organization (NRSRO) and, if rated by multiple major NRSROs, rated at least BBB-/Baa3 by two or more NRSROs, in each case subject to review by the Federal Reserve; and (iii) have a remaining maturity of five years or less (Board of Governors of the Federal Reserve 2020).

Companies prefer this method of financing when raising capital because the interest payments of these bonds is usually less than the interest rate available through other sources of borrowing such as banks, and private firms. Compared to banks or private loans, issuing bonds allows firms to borrow larger amounts at lower rates with greater freedom, and fewer debt obligations/restrictions.

For all intents and purposes, this research mostly focuses on the corporate bond purchases of the SMCCF to help facilitate access to credit from the time the announcement was made on March 30th, to the actual purchases of the transportation bonds spanning until August 2020. According to the Federal Reserves, in a press release received on March 23, 2020

The Federal Reserve is committed to using its full range of tools to support households, businesses, and the U.S. economy overall in this challenging time. The coronavirus pandemic is causing tremendous hardship across the United States and around the world. Establishment of two facilities to support credit to large employers – the Primary Market Corporate Credit Facility (PMCCF) for new bond and loan issuance and the Secondary Market Corporate Credit Facility (SMCCF) to provide liquidity for outstanding corporate bonds (Board of Governors of the Federal Reserve 2020).
When observing the Board of Governors’ broad market index of bond purchases, the transportation sector received one of the lowest percentages of funding relative to other sectors. How did this affect the corporate bonds of one of the hardest-hit industries by Covid?

Inside this general support for the financial system, there was a direct subsidy which came in terms of financing spreads for parts of the financial system. When looking at the secondary market corporate credit facility transaction disclosure at first glance, it appears that the transportation sector was short-changed in terms of the percentage of the specific type of support, however, this sector may have received large sums of liquidity through other sources, thus, I will determine if an appropriate subsidy was provided in the form of a spread reduction on their bonds trading in the secondary market relative to US treasury and government risk-free bonds. This paper aims to assess changes in credit spread dynamics across various segments of the transportation industry in response to the SMCCF market in order to determine whether the liquidity provided to critical segments of the transportation industry, such as trucking, railroads, and shipping firms, was sufficient to keep its cash flow sustainable and appealing to the investors in the secondary market. Note that other forms of measures were enacted by the Federal Reserve to support businesses in the U.S economy and could have impacted the financing of sectors within the SMCCF but due to the precision of our research focusing solely on corporate bonds transactions from the SMCCF, we reduce the influence of other programs and monetary policies on our estimate. Plus, an adequate amount of funding regardless of the measure will be reflected in the changes of credit spread of an issuer as sufficient access to cashflow to the transportation sector will be displayed as a reduced perception of risk by those in the secondary market and increase consumer confidence and thus reduction in basis points.

On April 9th 2020, the Federal Reserve announced additional funding for the SMCCF to Increase the flow of credit to households and businesses through capital markets, by expanding the size and scope of the Primary and Secondary Market Corporate Credit Facilities (PMCCF and SMCCF) as well as the Term Asset-Backed Securities Loan Facility (TALF). These three programs will now support up to $850 billion in credit backed by $85 billion in credit protection provided by the Treasury. Eligible issuers must satisfy the following conditions: 1. The issuer is a business that is created or organized in the United
States or under the laws of the United States with significant operations in and a majority of its employees based in the United States. 2. The issuer was rated at least BBB-/Baa3 as of March 22, 2020, by a major NRSRO, and, if rated by multiple major NRSROs, the issuer must be rated at least BBB-/Baa3 by two or more NRSROs as of March 22, 2020. a. An issuer that was rated at least BBB-/Baa3 as of March 22, 2020, but was subsequently downgraded, must be rated at least BB-/Ba3 as of the date on which the SMCCF makes a purchase, and, if rated by multiple major NRSROs, such an issuer must be rated at least BB-/Ba3 by two or more NRSROs at the time the SMCCF makes a purchase. 3. The issuer is not an insured depository institution or depository institution 4. The issuer has not received specific support pursuant to the CARES Act or any subsequent federal legislation. 5. The issuer must satisfy the conflicts of interest requirements of section 4019 of the CARES Act (Board of Governors of the Federal Reserve 2020).

There has been research already conducted by multiple authors, JN Liang (2020), S Mazumder (2020), that showed the significant positive impact that the corporate credit facility had on the bond market and elevating investor confidence with improved financial conditions for eligible issues. With this in mind, I go on to examine to what extent the shipping, trucking, and railroads firms benefited from this specific Special Purpose Vehicle (SPV) that was announced in March of 2020 and ended in December 2020. Then afterward we proceed with an empirical panel regression framework that examines how the yield to maturity changes as the result of the Federal Reserve announcements (while simultaneously controlling for macroeconomic indicators like the slope of the yield curve). We want to examine if this was a sensible way for the Federal Reserve to intervene in light of the pandemic response.

The Goal: By using credit spread as a form of evaluation for eligible SMCCF bond issuers of the transportation sector, we want to assess the access to credit given to the transportation sector as this is essential for the value, we give these debt securities and also good for policymakers to evaluate how the financial markets responded to the measures that are in place. Hopefully, we will learn from these projections and gather more price market information to develop economic policies and laws that could help us continue being successful in the reforms that work and improve on the ones that do not work in this business climate.
2 LITERATURE REVIEW

The influence of the Secondary Market Corporate Credit Facility on the financial market, as well as the Fed's beneficial role in decreasing basis points for most qualifying SMCCF issuers through this special purpose vehicle, has been the subject of several studies and research. I start by reviewing written empirical studies on SMCCF’s efficacy and overall performance in providing credit to qualified issuers while also lowering bond spreads. I then proceed to examine literature pieces that studied how credit spreads and basis points changed in various sectors before and after the secondary corporate credit facility announcement. The final section examines the impact of Covid on eligible issuers of the transportation industry, as well as causality, and macroeconomic indicators that might also affect the transportation industry's credit spread, in order to assess how one of the most heavily impacted sectors, with one of the fewest accesses to SMCCF credit, has fared since the creation of the bond purchasing program.

2.1 The effectiveness of the SMCCF in providing liquidity to eligible corporate bond issuers

In response to the disruption in the economy that led to sales collapses, increase probability of default, and disruptions in the supply chain, the secondary credit corporate facility was created. Xu (2020) found that there was a significant difference in yield spread of highly rated bonds with less than 5 years of time to maturity relative to bonds with lower credit ratings and higher durations. The decrease in basis points of bonds with maturity of fewer than 5 years has largely contributed to the increase in demand and trading incentives after the Federal Reserve’s March announcement of bonds that are deemed eligible for government purchase. Hui Xu (2020) concluded that the SMCCF significantly enhanced the liquidity conditions of the corporate bond market so much so that it had a positive spillover effect and reduced the credit spread of non-eligible SMCCF issuers. To examine the robustness of his finding Hui Xu performed a difference-in-difference study and concluded that the SMCCF predominantly targeted US investment-grade bonds. Similarly, to my model, Xu used the bond yield spreads, defined as the difference between the yield the bond (in interest) is trading at and a U.S treasury yield at the same maturity, as his dependent variable. Xu compared the changes in outcome over time between bonds issued by US issuers and “Yankee” bonds classified as bonds issued by foreign issuers, in the period before the Fed’s announcement of SMCCF and the period after. Xu also controlled for the bond’s trading day fixed effect and created a dummy variable for eligible
bond issuers in the corporate credit facility that was implemented as one of his explanatory variables in order to provide the most accurate measure for this difference in difference method. Throughout this empirical framework, Xu concluded that higher credit rating AA/A issuers greatly benefited by the impact of the SMCCF, with the benefits decreasing proportionally to a bond's low credit rating. Overall Xu manage to show that the Federal Reserve did in fact manage to improve the corporate bond liquidity, however, Xu has shown us that there was a noticeable deviation as certain eligible issuers with massive scale operational costs greatly benefited from this special purpose vehicle compared to smaller firms with lower operations of scale. This was to be expected as the Board of Governors stated in a speech on October 20th, 2020, that “large businesses spill over to smaller firms, perhaps accounting for 10 percent of the reduction in employment at small firms during the last recession” (Executive Vice President Daleep 2020). So, this divergence is to be expected and was purposely initiated as the Fed targeted larger firms due to their larger presence in the market. All the firms from the transportation sector had noticeable market share within their respective industries so we should expect each and every one of them to receive a great deal of funding based on the Federal Reserves remarks.

2.2 The examination of credit spreads and basis points within the eligible issuers of the SMCCF

Similar to the previous author Simon Gilchrist, Bin Wei, Vivian Z. Yue, and Egon Zakrajšek (2020) in their paper titled “The Fed Takes on Corporate Credit Risk: an analysis of the efficacy of the SMCCF” uses difference in difference analysis to examine how the Federal Reserve’s announcements on the creation of the corporate credit facility had a significant effect in the reduction credit spreads of eligible companies on an aggregate level. Using regression discontinuity and samples of bonds qualified and unqualified for the SMCCF, the authors showed that investment-grade bonds or bonds with high credit ratings with maturities of 5 years or less (thereby making them qualified for the SMCCF) experienced a drop of 70 basis points compared to investment-grade bonds which had maturities that extended five years during the period that the Fed made the April 9th announcements. According to the authors, the problem of discontinuity arises when comparing the effect of the SMCCF on bonds available for purchase
under the stated program to bonds not eligible for purchase by the facility. The authors measured the difference between the impact of the credit spread of eligible issuers denoted as the treatment and the credit spread of the non-eligible issuers known as the control group. The March 23rd announcement had a differential effect between the treatment and control group of “fallen angels”, (bonds that are downgraded from investment grade) as the author observed that in reaction to the announcement, the SMCCF-eligible bonds issued by fallen angels increased by around 340 basis points relative to their non-eligible counterparts. Counterintuitive to say the least, the authors explained this to be a delayed reaction such that

First, the actual downgrade to junk status would, all else equal, lead to an increase in credit spreads in both the treatment and control groups. The much larger estimated increase in credit spreads on the fallen angels’ treated bonds is likely due to investors’ perception that the downgrade-induce. increase in default risk was heavily concentrated in the near term, leading to an inversion in the term structure of credit risk for these companies. Second, following the downgrade, the fallen angel’s SMCCF-eligible bonds were no longer eligible for purchase by the facility. Losing eligibility for bonds in the treatment group could additionally drive up their credit spreads relative to their counterparts in the control group. Both factors—the rising near-term credit risk and the loss of eligibility status—may thus induce a differential effect between credit spreads in the treatment and control groups (Gilchrist, wei, Yue, Zakrajsek, 2020).

The April 9th announcement went on to reverse this effect of the SMCCF-eligible bonds with a reduction of 175 basis point difference over the ineligible equivalents of the fallen angels. This discontinuity and delayed effect by the eligible fallen angels’ issuers demonstrate that the financial markets can take unexpected results, especially for corporate issuers with low credit ratings. The Fed's transaction-specific disclosure reveals that not only did the transportation sector have one of the lowest percentages of overall par value, but that the eligible issuers had bonds with low credit ratings. The authors' approach to evaluating the impact of the SMCCF demonstrates that market anomalies can occur and result in unexpected outcomes. Assessing the credit spread of investment-grade bonds vs lower-rated junk bonds should provide an accurate indication of the government's intervention in the transportation sector. The database that is used by the majority of the authors is TRACE, Finra. TRACE, short for Trade Reporting, and Compliance Engine, gives detailed information about bond transactions, bond market trades, and other activity that happens in the bond financial market. This platform was launched back in 2002 and provides over-the-counter transparency and fairness to the people who have access to
the data. This information includes bond prices, bond trades, and the volume of trade in addition to yields on all types of bonds, from corporate bonds to municipal, and government bonds. The Primary Market Corporate Credit Facility and Secondary Market Corporate Credit Facility would fund $500 billion in primary market purchases and $250 billion in secondary market purchases respectively, with $75 billion coming from the Treasury Department and the Coronavirus Aid, Relief, and Economic Security Act (Board of Governors of the Federal Reserve 2020). All of this is shown in the TRACE dataset. A term sheet was released after the bond purchases were terminated back December 31, 2020. This term sheet included the certain type of bonds that were purchased by the government which included a total of the 14.2 billion in fixed income assets. Ultimately what I and other researchers focused on when assessing the efficacy and fairness of the bond-buying program was the broad market index. According to the Board of Governors in the Federal Reserve bank of New York, ‘The Broad Market Index is designed to follow the composition of a large, diverse universe of secondary market bonds that fulfill the requirements set out in the Term Sheet for Eligible Broad Market Index Bonds, subject to the Term Sheet's issue-level limits. It was recalculated at least once every 4-5 weeks, and the list of bonds that are eligible for purchase was updated more often to add or delete bonds that have recently met or no longer met the eligibility conditions’ (Federal Reserve Bank of New York, 2020).
The writers, Simon Gilchrist, Ben Wei, Vivian Z Yue, and Egon Zakrajsek (2020) were motivated by this information when observing how equitable the distribution of cash has been given to the different qualified issuers, as well as the efficacy of this special purpose vehicle. My study and interest in this wide market index have homed in on the transportation sector. The overall composition of the Initial Broad Market Listing is shown below,

Table 1: The Composition of the Initial Broad Market Listing, 2020

<table>
<thead>
<tr>
<th>Sector</th>
<th>No. of issuers</th>
<th>Weight (%)</th>
<th>Issuer with the largest weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Industries</td>
<td>41</td>
<td>3.6</td>
<td>DuPont De Nemours Inc.</td>
</tr>
<tr>
<td>Capital Goods</td>
<td>70</td>
<td>7.4</td>
<td>General Electric Co.</td>
</tr>
<tr>
<td>Communications</td>
<td>33</td>
<td>7.8</td>
<td>AT&amp;T Inc.</td>
</tr>
<tr>
<td>Consumer Cyclical</td>
<td>73</td>
<td>16.2</td>
<td>Toyota Motor Credit Corp.</td>
</tr>
<tr>
<td>Consumer Non-Cyclical</td>
<td>101</td>
<td>20.4</td>
<td>AbbVie Inc.</td>
</tr>
<tr>
<td>Energy</td>
<td>78</td>
<td>9.5</td>
<td>BP Capital Markets America Inc.</td>
</tr>
<tr>
<td>Insurance</td>
<td>72</td>
<td>8.0</td>
<td>Metropolitan Life Global Funding Inc.</td>
</tr>
<tr>
<td>Nonbank Financials</td>
<td>41</td>
<td>2.1</td>
<td>International Lease Finance Corp.</td>
</tr>
<tr>
<td>REITs</td>
<td>56</td>
<td>3.2</td>
<td>WEA Finance LLC</td>
</tr>
<tr>
<td>Technology</td>
<td>55</td>
<td>9.2</td>
<td>Apple Inc.</td>
</tr>
<tr>
<td>Transportation</td>
<td>18</td>
<td>2.6</td>
<td>Burlington North Santa Fe LLC</td>
</tr>
<tr>
<td>Utilities</td>
<td>156</td>
<td>10.4</td>
<td>NextEra Energy Capital Holdings Inc.</td>
</tr>
</tbody>
</table>

Source: Simon Gilchrist, Ben Wei, Vivian Z Yue, and Egon Zakrajsek’s (2020) calculation using data from the Federal reserve bank of New York

I evaluate the credit spread movements of the most important transporting businesses that are critical to the economy's supply of cargo and trades like railroads and shipping firms as well as businesses that mostly focused on consumer travel like Delta. Similar to these authors, I will examine the effects of the credit spread of the transportation sector before and after the announcement of the special purpose vehicle, and also after the Federal Reserve started the actual purchases of the program. We see from Table 1 above that even if we were to double the number of issuers and weight (%) in the transportation sector it would still be far less than most of the other sectors in this composition. One possible reason is that the Fed has tried to match its portfolio to the composition of the U.S debt market in the form of capitalized weighted index. S&P Global ratings portrayed a table which I transformed into a pie chart of the U.S corporate
debts market in the year 2019. More details of this capitalized weighted market are shown in my methodology, but to highlight a few points, in total the transportation debt composed of investment grade and speculative grade made up 2.8% of the total size of the debt market at this time while making up 2.6% of the Federal Reserve’s portfolio. To give another example, the utility sector made up 9.2% of the total bond debt market back in 2019, and similarity made up 10.4% of the Federal Reserve’s portfolio. So, this theory is very possible, but my analysis then goes on to show the effectiveness of the impact it made on the bonds of the transportation sector.

2.3 Covid impact on the transportation industry

Similar to my analysis, Susan Holte, and Stacey Mumbower (2020) in their paper titled, “The impact of Covid-19 on domestic U.S. air travel operations and commercial airport service”, assess in particular how the transportation industry was affected by the reduction in air travel in both the commercial airline service and essential country’s operational services using data from the Bureau of Transportation Statistics (BTS) and Federal Aviation Administration (FAA) websites. ¹ Their study differs in that I approach the research of the transportation industry through the financial market and monetary standpoint whereas they observe the transportation

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¹ Holte and Mumbower 2020 also looked at trends in the number of monthly departure operations, including scheduled and completed departures, from January 2019 to May 2020. When reporting and discussing percentages (%) changes in operational data, year-over-year changes for a certain month were utilized to account for the seasonality of air travel, and because the CARES Act was signed into law on March 27, 2020, the month of May was chosen as a benchmark. In addition, this study analyzes the number of domestic markets served before and after the start of the pandemic to assess Covid's market-level impact on commercial U.S. airport operations (Holte, Mumbower, 2020). To briefly conclude, there was an almost 70% year after year in essential operational departures. Compared to leisure airline networks markets that decreased by 26.6%. Essential operational services are more essential to the mobility of freight and other resources in an economy than commercial airlines whose goals are to get passengers to their desired location during a time when travel is prohibited. These findings show that critical air transport operations should be given precedence when it comes to credit allocation, as they have a greater economic effect than flights who prioritize on leisure trips. ¹
firms through real operation, balance sheets, employment conditions, and a non-fiscal standpoint. As previously said, the Federal Reserve stated in their October 20, 2020, conference that “shocks impacting large businesses have a spillover effect to smaller firms, perhaps accounting for 10 percent of the reduction in employment at small firms during the last recession” (Board of Governors of the Federal Reserve 2020). Susan Holte, and Stacey Mumbower confirmed this to be true as they observed that the magnitude of the pandemic impact has hit some airport firms more harshly than others.

Comparing May 2020 with May 2019, the total number of performed departures decreased by 73.7% at large hub airports, 72.9% at medium hubs, 69.4% at small hubs, 62.2% at non-hubs and 39.2% at non-primary airports. This indicates that airlines decreased their departure operations at larger airports more than at smaller airports. The pre-COVID-19 number of departures at smaller airports, especially at non-primary airports, are closer to the minimum service requirements than at the large hub airports. This prevented airlines from reducing their operations as much at the smaller airports. (Holte, Mumbower 2020)

The author explained the reasoning behind this non-uniform impact to be the CARES act minimum service requirements which allowed larger airports to inadvertently downsize to a larger scale relative to smaller airports. As a result, the authors' findings demonstrate the Federal Reserve's correctness and accuracy in their proposal to give bigger amounts of liquidity to larger businesses in each sector. It was predicted that this strategy would result in easier access to credit and a further reduction in basis points for larger bond issuers relative to smaller eligible SMCCF firms. Especially because the Federal Reserve clearly stated that the magnitude that Covid had on bigger firms would have a trickle-down effect on smaller firms should no intervention take place. We see this statement come to fruition as we witness several disruptions in the supply chains of numerous firms around the world making the transportation sector one of the most financially impacted.

2.4 Weather-related impact on the Transportation industry

The disruptions were not only due to the decrease in unemployment and lack of labor for crew vehicles but financially speaking, many firms did not have enough funds to sustain and maintain the materials needed for daily operations, not only because of pandemic related travel
restrictions but also due to extreme weather phenomenon. The Arab Trade Union Federation said it best in their paper titled “Impact of the Covid-19 on the transport industry” that,

“The coronavirus pandemic has brought about sudden changes for cargo transportation, impacting shippers, air freight, and transport companies around the world. Although cargo transportation is widely recognized as an essential activity, a number of cargo handling companies shut down operations during the outbreak while ports have been operating under restrictions. Cargo stored in high-risk areas without appropriate security controls or protective safeguards runs the risk of large losses from fire or extreme weather events, while delays may also result in cargo damage to perishable, or temperature-sensitive goods” (ATUC, 2020).

In addition, less frequent use of railroads, ships, and trains can lead to mechanical breakdown and extreme delays and add to the fact that we live in an environment of limited mobility, and limited repair parts and service hours would be less accessible. Oil usage plummeted during this period which led to oil being stored in floating vessels since the tanks would most likely be inactive. This led to 200 million barrels of oil and products in floating storage in tankers or around 5% of global carrying capacity. Many tankers were circling key oil ports and terminals in the United States, Europe, and Africa, posing hazards from harsh weather, piracy, and political unrest. This put the health and safety of the ship's crew in jeopardy with deregulations of the oil and different forms of bacterial infection (“Impact of the Covid-19 on the transport industry” (ATUC, 2020, 15). This unfortunate disruption can lead to shipping firms defaulting on their loan obligation in the secondary market thereby reducing their credit ratings and increasing their financing costs. Should government intervention suffice, we should see an improvement in the liquidity market for these firms with higher volumes of bond trades and reductions in basis points. Troubling weather outcomes further demonstrate the difficulties found by most transportation firms during these climates.

2.5 Tangible assets

My study of the transportation sector's credit spread in the secondary market corporate credit facility is intended to provide some insight into the liquidity conditions of qualified issuers in order to assess the effectiveness of the Fed's bond market intervention. We see from the Arab Trade Union and previous authors like Susan Holte that the transportation sector has the most tangible assets at high fixed costs. Authors Michael Halling, Jin Yu, Josef Zechner (2020) in their published article titled “How did Covid-19 affects Firms’ access to public
Capital Markets” analyze asset tangibility and its effect on the credit spreads of the most impacted firms by Covid. Asset tangibility, or physical capital with finite monetary value, can serve as a liability if those assets depreciate quickly and are not adequately used in the frequency that they once were before Covid. So, when we think about the physical capital of the transportation sector and the massive downscaling it experiences due to lockdowns and restrictions, we see that these firms did not recover as quickly due to their over-reliance on inflexible fixed tangible assets, hence tangible assets are inflexible, particularly so for firms operating in certain industries whose revenue-generating process relies to a large extent on social mobility and personal interaction (e.g., McDonald’s depending on customers eating in their restaurants). Such industries are expected to be less resilient to the pandemic and to be more negatively affected by associated lockdown restrictions. As a consequence, spreads on bonds issued by firms from those industries should increase with tangibility and that is precisely what we find when rerunning our spread regressions for firms operating in retail trade, restaurant, hotel, and transportation industries (Halling, Yu, Zechner, 2020).

This study shed further light on the negative impact of Covid on the transportation industry and the difficulties of qualified issuers of the Secondary Corporate Credit Facility, such as United Parcel Service. Because of their role as shipping, receiving, and supply chain firms, UPS and other transportation companies are thought to be the most difficult to recover. Findings like this form the foundation of my thesis' inspiration. We know that the Federal Reserve took several steps to ensure that businesses across the United States had enough credit to stay afloat, including the commercial paper funding facility, the paycheck protection program, money market mutual funds, and term asset-backed securities loan facility, and municipal liquidity facility, but how successful was their targets? As we have seen from multiple literature reviews, these quantitative easing measures may have helped to rebuild faith in the corporate bond market, allowing businesses with lower credit ratings to participate. Hallings, Yu, and Zechner also aligned with the Fed’s statement that access to credit should be prioritized for larger firms as they find that firm size is the only explanatory variable that predicts increased usage of market-based debt, that is, corporate bonds, during recessions. We also document that profitability is negatively associated with the level of market-based debt during recessions. In accordance with both these results, the average size (average profitability) of issuing firms during the COVID-19 crisis is also significantly larger (significantly smaller) than that of issuers in noncrisis periods (Hallings, Yu, Zechner 2020).
Holte, Mumbower, and Yue (2020) also observed in their findings that there is a higher level of vulnerability towards larger firms, especially those which need to maintain larger quantities of tangible assets.² The authors have shown in their multiple regression models that tangibility has a positive or increasing effect on credit spread.

The role of tangibility as a determinant for credit spreads is Halling, Yu, and Zechner’s empirical model. In the author's empirical model, tangibility had very low statical significance, or in other words, little effect on credit spread for non-manufacturer firms. However, this variable is very revealing in many ways because, during Covid, firms with more physical assets were more likely to be negatively impacted by the necessary social distancing measures. As a result, these businesses might have been less resistant to the epidemic (Halling, Yu, Zechner, 2020). Integrating tangibility in my empirical model of eligible SMCCF will be instrumental as it helps better determine if the property and equipment for essential transporting firms, (accounted for accumulated depreciation and amortization) were a significant factor in the determination of credit spread, and indicator of adequate financing.

2.6 Bond Spread puzzle

It is essential to correctly assess and forecast the projection of credit spread of eligible bond issuers in the transportation sector and reduce the standard error as much as possible to generate accurate results. Liang Guo (2013) in his research discusses whether some credit spread observations can be linked to information risk and ambiguity regarding the probabilistic structure of the process that drives credit securities' underlying value. In other words, multiple researchers have examined variables and economic indicators that will serve best at predicting the credit spreads in financial markets. The reasoning behind this ambitious study is the credit spread puzzle. Guo (2013) showed that the motion of credit spreads and the factors behind the movements of these spreads in certain structural models cannot fully be measured.

² When examining the determining factors of spreads of corporate bonds during the crisis, the authors examined whether the issuers were relatively active in the secondary market, with a long track record of issuing bonds using the year 2009 as the threshold to distinguish active and inactive bond issuers. So for example, Fox corporation was a first time bond issuer since it has not issued any corporate bond since 2009. Other characteristics that were examined included the profitability of the corporate bond issuers, dividend yielding issuers, and the history and previous records of average spreads, and credit ratings of those firms.
Svetozar Jargic (2017) also briefly goes over the credit spread puzzle and multiple researchers follow suit, constructing different models in order to have an accurate measurement of credit spread determinants. Corporate bond spreads are typically many times larger than what projected default losses alone would imply. This can sometimes be a problem when forecasting the spreads of certain financial markets. The difference between the spread and the expected default losses is what is denoted as the credit spread puzzle. Jennie Bai, Robert S. Goldstein, and Fan Yang (2020) touched on this topic in their research titled “Is the credit spread puzzle a myth (2020)” as they try to find evidence of the credit spread puzzle on investment-grade bonds. Darrell Duffie, Leandro Saita, Ke wang (2007) examine the predictions of corporate default and concluded that the distance to default (a volatility-adjusted measure of leverage), the firm's trailing stock return, the trailing S&P 500 returns, and US interest rates all influence future default probability. Hence, common financial market factors, and firm-specific factors are good estimators of default probability. Astrid Van Landschoot (2004) in her paper titled “determines of credit spreads” solidifies the findings of previous research before her in her empirical findings of the analysis of the factors behind corporate bond spread in US and European markets. A negative relationship exists between the slope of the risk-free term structure and changes in credit spreads. Credit spread movements are reduced by high returns and a decrease in the volatility of the DJ Euro Stoxx. With increased liquidity risk, credit spreads vary dramatically. Subsequently, the author does go on to concede that a respectable portion of the variations in credit spread is still left unexplainable.

Svetozar Jargic (2017) believes credit spread predictability may be enhanced by using the appropriate explanatory factors, which are chosen depending on the sample size's features. He also concludes that systematic variables are better forecasting measures of bonds with higher credit ratings compared to idiosyncratic variables that are best at measuring bonds that are not investment-grade bonds, and the incentive for these research is that structural models performed poorly, which is why researchers such as Jargic set out to find new credit spread drivers that may help explain the credit spread puzzle. Eventually, Svetozar Jargic concluded that

For lower-medium investment grade bonds volatility of interest rate, volatility of credit spread and inflation have a positive influence on credit spread. For non-investment grade bonds return on stock price has a negative effect on credit spread and volatility of credit spread has a positive influence on credit spread. After a profound analysis and interpretation of the obtained results, the important variable for lower-medium investment grade bond is the volatility of interest rate and for non-investment grade bonds it is return on stock price.

(Svetozar Jargic 2017)
In his selection of bonds, his first criteria were that bonds should have a 5-year maturity from the day of issue, and all bonds should have yields to measure credit spread. In addition, all the bonds must be denominated in the same currency, Euros, in the context of his research. The author also focused on two samples, one of which consisted of lower-medium investment-grade bonds and the other all non-investment-grade bonds. Both samples consisted of several company bonds measured over long periods of time sorted in a Panel data structure, a combination of cross-sectional and time series. However, the author touches upon the problems that can occur when using time series analysis in a regression model such as heteroskedasticity, and serial correlation, AR(1) processes. The author in addition implemented a fixed model effect including his dependent variable, credit spread changes in response to his independent variable, which is composed of inflation, volatility of risk-free interest rate in the systematic variables, and volatility of firm individual credit spread, and returns on historical firm individual stock prices for the idiosyncratic variables. When investors watch the economy flourish and thrive to the point where inflation expectations are strong and positive, demand for goods rises, resulting in increased income streams for businesses throughout the economy. This assures investors that most firms will not fail on their loan commitments, lowering the credit spread and resulting in a positive correlation. Jan J.G Lemmen and Charles A.E Goodhart (1999) in their paper titled “Credit risks and European government bond markets: a panel data econometric analysis”, further showed that there is a highly positive correlation between credit spread in the debt to GDP ratio and variability of inflation in the form of fixed-effect panel data from the European Commission. Luis Oliveira Jose and Dias Curto Joae Pedro Nunes (2012) considered the level of consumer prices when controlling for inflation in measuring the economic climate of government credit spreads in the Euro area. All in all, controlling for these macroeconomic effects is essential so as to not let our dependent variable, bond spread, be influenced by any other factors besides our main explanatory variable, the Federal Reserve’s announcements of the bond program, and eventual subsequent purchase.
2.7 Liquidity Component

Liquidity is also seen as a significant component of credit spreads. An increase in liquidity translates into higher and more frequent buy and sell transactions towards a corporate bond. Bonds with higher trading volumes tend to be of higher credit ratings and lower credit spread. Many authors (Perraudin and Taylor 2003), and most notably Long Chen, David A. Lesmond, and Jason Wei (2007) in their paper titled “Corporate yield spread and bond liquidity” examine the relationship between corporate bond liquidity and yield spreads and concluded that liquidity improvements cause a reduction in yield spreads when controlling for macroeconomic variables, and firms specific traits. Their model was robust to the corporate bonds’ issuers’ fixed effect and possible endogeneity biases. The macroeconomic variables in his regression also included S&P rating, treasury rate, 30-day Eurodollar rate, debt to assets ratio, and also a debt to capitalization. Their sample size spreads over 4000 corporate bonds of a variety of credit ratings.

For investment-grade bonds, the LOT liquidity estimate alone explains 6.39% of the cross-sectional variation in the bid-ask spread, while the percentage of zero returns explains 6.82% of the cross-sectional variation in the bid-ask spread (Wei, Chen, Lesmond, 2007).

For speculative bonds, only the bid-ask spread, and the LOT measure are significantly associated with the underlying yield spread. The LOT measure explains 7.39% of the cross-sectional variation in the yield spread, while the bid-ask spread explains only 0.86% of the cross-sectional variation in the yield spread (Wei, Chen, Lesmond, 2007).

We know that the secondary market has significantly increased its trading volume for all credit ratings especially junk bonds since the Fed announced its plan for the SMCCF. This significant impact on the financial market is shown below.
One of the most remarkable findings in Long Chen, David A. Lesmond, and Jason Wei’s (2020) research on corporate yield spread is that bond volatility, the change in the corporate bond prices throughout the announcement given a change in yield to maturity during this near-zero interest rate environment, was instrumental in explaining bond liquidity. This is instrumental because it has been proven in multiple research studies that change in liquidity heavily affects the fluctuation of corporate yield spread, regardless of other macro-level variables as the authors have seen that all the bonds in their sample have experienced liquidity effect. Long Chen, David A. Lesmond, and Jason Wei have used a time series regression model and implemented the difference-in-difference method in order to remove any form of autocorrelation that could potentially jeopardize the accuracy of their results. In addition, they also found that a reduction in bond quality (or bond ratings) leads to an increase in yield spread. Macroeconomic firm-specific variables like the treasury rate and S&P ratings also increase the explanatory powers of bond yield spread.
2.8 Macroeconomic casual effect of the Federal Reserve’s SMCCF

My analysis of the previous researchers had a particular focus on the credit spread in the determination of the state of the corporate bonds. Sharil M. Haque, and Richard Varghese in their article titled “Credit in a crisis: Effects of the Fed’s Corporate Bond Market intervention” (2021), raised important implications in reference to firm-specific conditions of capital expenditure, reduction of firm default probability, and the effectiveness of the financial market outcome in transforming firm-level specific outcomes. The authors controlled for flight to quality by performing a difference-in-difference model on a group of bonds that were eligible for the SMCCF program, and a group of investment-grade bonds that were not eligible for the program. The difference in difference effect was used to measure the causal effect of the SMCCF. The authors performed this trial to examine how, in the wake of the Federal Reserve’s announcement, investors were willing or non-willing to purchase quality investment grade compared to high-yielding bonds and how the credit spread of these different credit rating bonds was impacted over time. The author closely examined purchase effects, The Federal Reserve’s announcement effects, and firm-level effects of the SMCFF. The data was obtained from a Finra Trace sample of corporate bonds, similar to what I will be using in my analysis. With close examination of their empirical model for firm-level effects, the authors did not limit themselves to one dependent/responding variable but rather the model was composed of long-term debt as a share of total debt, real investment measured by quarterly change in property, plants, and equipment by total assets, and cash scaled by total assets. When examining the model's explanatory variables, one of them was an interactive term called post X eligibility. This interactive term examined how liquidity circumstances altered overtime during SMCCF initiations and also how businesses sought substantial capital increases out of concern of the volatility and unpredictability of their access to liquidity, rather than investment goals. This signifies that firms across the U.S were approaching financing troubles during the pandemic in a more conservative approach due to the disruptions in their income stream and cash flow, especially for firms with lower credit ratings who had a harder time borrowing funds since they were not as trustworthy through the eyes of the investors. This finding applies to all firms across the U.S, and not just to the eligible SMCCF issuers. These findings further show the desperate need for firms during the pandemic as there was an increase in demand for accumulated liquid
assets that could easily be converted to cash for long-term and short-term financing. Darmoni and Siani also showed in their research that firms with incentives to obtain more liquid assets are likely to experience times of financial hardships and trouble (Darmoni Siani 2001). Hence, these actions from the firms demonstrate the financial uncertainty that was occurring during this period of time.

In Sharjil M. Haque, and Richard Varghese’s empirical analysis through the treatment group of investment graded bonds that satisfied the criteria for the SMCCF eligibility and the control group which was composed of bonds that did not meet such criteria, we see that the program, on the aggregate, did have a positive effect for easier access to credit and better borrowing condition for eligible companies. To further elaborate on their baseline results,

We also include fixed effects at the bond level to control for time-invariant characteristics such as offering date, offering amount, maturity, coupon, and if the bond is callable, secured etc. Finally, we include month-fixed effects. Our key variable of interest is \( \text{Post} \times \text{Eligible} \) which captures the effect of the SMCCF on eligible issuers. A negative interaction term for Bid-Ask Spread and Bond Yield indicates the program was able to improve liquidity conditions and reduce borrowing costs respectively. A positive sign for the interaction in the specification estimating price return indicates the program improved valuations of eligible corporate bonds (Haque, Varghese 2020)

From the given results we see that post eligibility was very statically significant and this incorporation in the model has led to the reduction of bid-ask spreads by 0.23 percent and 0.14 percent, bond yield by 1.575 percent, and 1.228 percent, and price return by .024 percent and .009 percent. The flight to quality used the interaction term of \( \text{POST}_t \times I\text{G}_{it} \) and incorporation of this interaction term in the empirical model made “primary estimate on bond yields drop significantly” (Haque, Varghese 2020, 16). The variable post was a dummy variable equal to 1 from June 2020 onwards to December that occur during the same time as the bond-buying program, and 0 at any period of time before June. The authors show that the impact of the bond yields and price returns were largely due to the actual purchases of these bonds rather than just the announcement alone by running a dynamic difference-in difference-model that included various months of the announcement and moments leading up to the actual purchases as an interaction term of both eligible and
non-eligible bonds, in addition to the characteristics of the bond including the maturities, and coupon rate. The results were that

None of the coefficients prior to the SMCCF announcement was statistically significant. Next, we see that the coefficient estimate turns sufficiently positive but is still statistically insignificant in March 2020 (month of SMCCF announcement). Only from \( t \geq 3 \) do we see the previously documented reduction in bond yield which indicates the coefficient estimates became statistically significant from June 2020 onwards and remained negative and significant each month till the end of our sample. Thus, only following actual purchases do we observe a statistically significant reduction in bond yield in eligible issues relative to InvGrated ineligible issues (Haque, Varghese 2020).

However, it should be noted that the level of success that came about from the bond purchases of the SMCCF resulted mostly in the stability of the financial markets and financial securities of the individual bonds rather than the balance sheets, and tangible assets for these eligible issuers. The author in his empirical analysis showed that firm-level outcomes such as liquidity ratio, profit margins, and log PPP did not yield as much success. The author did this by combining the characteristics and bond traits such as credit ratings, coupon rate, and maturity date with firm-level balance sheet information and using sources from U.S Compustat to do a comparative analysis. The author collected a total capital accumulation of around 550 firms in his sample. The outcomes of these firm-level effects did not carry the same success as the financial market outcome, although the SMCCF also positively impacted the ineligible issuers almost as much as eligible ones regarding liquidity effects and cash holdings.
3 METHODOLOGY

3.1 Functions of Bonds and Investor’s concerns during uncertain times/Default risk

Corporate bonds are financial instruments issued by a firm to obtain funds for a variety of purposes, including operation expenditures and business growth. The yield on a corporate bond is the projected rate of return represented as a percentage. Investors take on the risk of acquiring corporate bonds with the goal of earning interest in addition to the par value when the bond matures. Investors may also sell their corporate bonds in the secondary market to other investors. The point here is that the year 2020 prompted a significant degree of dread and uncertainty in the financial market as a result of the epidemic and its economic ramifications such as cash flow problems for several businesses throughout the United States. This led to fewer investors wanting to acquire corporate bonds on the secondary market in the same period of time when many investors were eager to sell their bonds in anticipation of corporations defaulting due to pandemic-related difficulties. As a result, the Federal Reserve purchased corporate bond-related assets from investors in the secondary market, (thus the name "Secondary market corporate credit facility") in order to inject liquidity into the financial market and boost the number of buying and selling transactions as needed. Corporate bonds are deemed to be riskier than government or municipal bonds, which practically never default. And thus have a higher interest rate to compensate for the increased risk. As a result, investors requested higher interest payments during the pandemic to compensate for the uncertainty of pandemic disruptions.

To determine the impact of the Fed's program on qualifying issuers in the transportation industry, I utilized credit spread, or bond spread, as an indicator. Default risk refers to the probability that the issuer of a bond would default on its financial commitment; in other words, default risk is viewed as a measure of creditworthiness, similar to how individuals have credit scores. To evaluate the bond's default risk, I subtracted the difference between the yield of a corporate bond to the yield of a US Treasury bill with a similar maturity. Bonds classified as investment-grade with high credit ratings are regarded as having minimal default risk, or minimal spread over the U.S treasury. A corporate bond with a lower credit rating that is not
regarded as investment grade has a greater risk of not meeting its debt obligations, implying a greater likelihood of the bond's issuer defaulting on its payment, or a higher default risk. As a result, increased default risk relates to increased interest payments to persuade investors to acquire the low-rated bond. My objective is to study the default risk of a few selected bonds in order to determine the influence of the Fed's announcement and subsequent purchase.

3.2 Key Concept (Fixed effect model, Panel Data)

There are several approaches that may be used to acquire data for my credit spread analysis. My data is unique in that it combines cross-sectional and time series analysis in order to track the performance of the bonds from the transportation firms that qualified for the secondary market corporate credit facility in 2020. Given that we are witnessing the same sample of bonds issued by the group of corporations over a certain time period, a fixed effect panel data set is the most appropriate for this research. I wish to account for any time-invariant unobserved firm characteristics that may be linked with the model's specified independent variable. There are methods of formulating fixed-effect model, one way defined as \[ Y_{it} = \beta_1 X_{1,it} + \ldots + \beta_k X_{k,it} + \alpha_i + \mu_{it}. \] The \( \alpha_i \) are entity-specific intercepts that capture heterogeneities across entities. Letting \( \alpha_i = \beta_0 + \beta_2 Z_i \), where \( Z_i \) are unobserved time-invariant heterogeneities across the different firms \( i=1,\ldots,n \). This can be rewritten with \( n-1 \) dummy regressors and a constant denoted as

\[
Y_{it} = \beta_0 + \beta_1 X_{1it} + \gamma_2 D_{2i} + \gamma_3 D_{3i} + \ldots + \gamma_n D_{ni} + u_{it}.
\]

The eligible transportation firms that were included in this special purpose vehicle include JB Hunt Transport Services Inc, Burlington Northern Santa Fe LLC, CSX Corp Delta Air Lines Inc, ERAC USA Finance LLC, FedEx Corp, Kansas City Southern, Norfolk Southern Corp, Penske Truck Leasing Co Lp / PTL Finance Corp, Ryder System Inc, Southwest Airlines Co, TTX Co, Union Pacific Corp, and United Parcel Service Inc. They are incorporated into my fixed effect model as dummy variables. Since Dummy variables are categorized as 1 or 0 we want the groups in our model to be mutually exclusive, we leave out one firm in order to avoid the
dummy variable trap. The firm that was left and served as a reference category is Burlington Northern Santa Fe LLC.

3.3 Data used in the study

Finra TRACE provides both real-time and historical transaction data on its qualifying securities, which include bonds. I utilized the FINRA Market Datacenter to obtain the current price and yield on the bonds of interest. The data gathering process comprises the following: bond identification (FINRA symbol and CUSIP number); execution date and time; price; yield; quantity (as reported and not subject to distribution restrictions); commission; and purchase or sell. I was also able to get the CUSIP number of the bonds purchased by the Federal Reserve for this special purpose vehicle via a transaction-specific disclosure statement available on the Board of Governors website. This sheet featured the Par value of the bonds obtained, the contractual settlement date, the purchase amount for each issuer, accumulated interest, the Coupon (percentage), the Amortized cost (US$), the bond issuers, and the various sectors from which the issuer came. A fresh transaction sheet was issued each month from the time of the announcement on March 30th through December 11th, 2020. Additionally, one can examine the SMCCF Broad Market Index for the selected sector, as well as the sector's percentage of total par value and total par value amount. I was able to study bonds obtained from the transportation industry and monitor the daily yields on such bonds from January 2nd, 2020, to December 31, 2020.

Another source of data used in this research is the US Treasury's daily interest rates. This data set contains the yields on risk-free US Treasury bonds with maturities of one month, two months, three months, six months, one year, two years, three years, five years, seven years, ten years, twenty years, and thirty years. The vast majority of corporate bonds included in this research had a total maturity of seven to ten years. I then estimated the yield differential between corporate bonds and comparable-maturity US Treasury bonds and used it as my dependent variable.
3.4 Model Computation/Excel

While the Trade Reporting and Compliance Engine (TRACE) and the Department of Treasury provided yield spreads on transportation sector corporate bonds and US treasury bonds, a certain amount of data cleaning and extrapolation was required to determine the bond yield spread between the transportation sector bond and a US treasury bond of the same maturity. As Hui Xu (Ibid, 31) did, I removed bond trades that were exchanged and reported as canceled or corrected in the TRACE database between January and December 2020. Fortunately, Finra identified such bond trades that were canceled or rejected, which simplified the data cleansing procedure. My data is structured as the daily frequencies of the yield. Furthermore, some days had multiple trades, and therefore multiple yields to maturity, so I average the yields that were conducted within the same days for my credit spread calculation. I did this in an efficient manner using the excel function. Given that my sample of eligible and non-eligible bonds for the SMCCF originated from the same corporation, I anticipate that the bonds will likewise have the same underlying solvency risk which thereby allows us to control for firm-specific features such as size, age, and the extent to which the firm is exposed to credit risk. In addition, my model also includes the quantity (par value of the trade) to control for bond characteristics that can influence the yield to maturity and price of the bonds within the financial market. Information for the bond characteristics were also obtained using TRACE.
3.5 Capitalized Weighted Index

Multiple authors, Hu 2020, Simon Gilchrist Bin Wei Vivian Z. Yue Egon Zakrajšek (2020), have shown in their papers that SMCCF when measured on the aggregate level, has had a pronounced effect on reducing the spreads of the eligible issuers of every sector as a whole. My research is a subset of that finding as I try to examine how the sector that received one of the lowest funding within the SPV fared throughout the whole of 2020. Thanks to the Board of Governors’ transparency with its bond portfolio throughout this special purpose vehicle we can see the broad market index sector percentage of total par value of its purchases. There could be a number of reasons why the transportation sector received one of the lowest allocations, one of them being that the Fed constructed its portfolio based on its capitalized weighted index in the bond market. We could therefore say that the sectors with the highest bond shares also carry a higher market cap. Hence, the transportation sector may just have a smaller portion of the total bond market capitalization. S&P shows the composition of the U.S bond debt market in the year 2019 in the figure below and a comparison of that with the Board of Governor’s portfolio. From the two-pie chart displayed below we can see that the total debt percentage for both investment-grade and speculative-grade of the transportation sector is very small accounting for 1.5% of the total Debt amount for corporate bonds, and 2.7% of the total Fed’s portfolio purchases. To see another example of how the Fed bought the U.S corporate bonds proportional to their market size/cap in the U.S Corporate debt market, utilities make up about 5.4% of the total U.S corporate debt market, and a little over 10.3% of the total Fed’s portfolio during 2019 as shown below (S&P Global 2019).
Figure 2: US Corporate Debt size in 2019

Source: Author’s calculation based on S&P Global table.
3.6 Corporate Bond spreads by Sector

Corporate spreads had been rising until the Fed’s intervention and decreased thereafter. These dynamics, however, are not uniform across sectors. Using similar data as I, Julian Kozlowski, Miguel Faria e Castro, and Mahdi Ebsim measured the change in spread before and after the March 23rd announcement, and this can be seen in the figure below. We find a difference in standard deviation between the spreads prior to and following the March 23rd announcement of the SMCCF. The authors assert that the decline in credit spreads on March 23 appears to be more consistent across sectors. The standard deviation of the initial increase is more than three times that of the subsequent drop.

Therefore, we can see from the graph and the author’s conclusion that the Fed’s policy moves were not sector-specific, but rather was meant to inject liquidity into the market with no clear direction. Thus, it seems as though all sectors were supposed to profit equally from these actions, even though they are affected differently by the shock. The transportation sector has
one of the lowest reductions in credit spread which aligns perfectly with the Fed’s position of the small percentage par value they obtained from the transportation bonds relative to other sectors.

Figure 4: The change in Corporate Bond Spreads by Sector, 2020

Source: Julian Kozlowski, Mahdi Ebsim, Miguel Faria (2020) calculation, Corporate Bond spreads and the Pandemic II: Heterogeneity across Sectors

3.7 Omitted variable bias/Included variable biases

The objective of this thesis is to see the bond yield’s response to two huge announcements and eventual purchases. While measuring the announcement effects there could be lots of confounding variables that could be affecting the outcome of our research as shown by multiple authors in the literature review. So, then I ask the question, what other variables are known to affect the movement of the bond yield in the secondary markets. More importantly, what variables out there could be determinates of the credit spread of the transportation bonds, and also be correlated to the Fed’s announcement of the start of the SMCCF. Through examination of various bodies of literature that explain factors that can affect the yield of a bond, I’ve come up with a series of control variables in my model that I believe to be correlated with the credit spread of researched bonds and the Federal Reserve’s announcements and that include macroeconomic indicators like the S&P transportation index, GDP, and the slope of the yield
curve. We also need to be wary of including variable biases, or improperly incorporating a factor in our model such that the credit spread of the bonds will be attributed to that factor, giving a false dichotomy because that factor is then in turn attributed to the Federal Reserve’s announcement variable. This will lead to a false estimation and lack of explanatory power given to that variable although the explanatory power properly belongs to the Fed’s announcement of the initiation of the SMCCF. One such example is the volatility index in the bond market. Indeed, day-to-day market activity changes drastically when investors have a preconceived notion of what the market might look like in the foreseeable future. A higher volatility means higher bond prices, and it is not a coincidence that bond market volatility hit a very high mark in March 2020, around the same time as the first Fed’s announcements. Hence, we are interested in the movement of the bond spreads throughout the Fed’s announcement, and we may think that controlling for attributes like the VIX could be used as a proxy of interest but in so far as the treatment (announcement effect) could in of itself impact the movements of the VIX. Similarly, this logic applies to the S&P transportation index. A variable that was initially implemented in my model based on references from previous literature which have shown the importance of the index in determining the bond yield spread. Therefore, controlling for variables such as the S&P transportation index may be useful, but the primary treatment, the Fed's announcement, may and most likely does impact this feature, as evidenced by numerous works such as Hui-Ju Tsai & Yangru Wu (2015) and (Kimberly Amadeo, 2022), in which both bodies of literature discuss the inverse relationship between stocks and bonds, as well as the secondary bond market selling. To prove this, I measured the correlation between the bond yields of the transportation companies in my research and the S&P transportation index.
Table 2: Correlation Coefficient of the S&P Transportation index and Transportation Bond spread

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<th>Default risk</th>
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<tr>
<td>Default risk</td>
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<tr>
<td>SPITN</td>
<td>-0.3617*</td>
<td>1.0000</td>
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Source: Author’s calculation

The image depicts the statistically significant negative association that exists among the two variables below the 5% level of significance. And, as previously demonstrated, the attributes ascribed to the stock market index of changes in the bond's credit spread can also be ascribed to the Fed's announcement; thus, we are presented with a false dichotomy if the S&P index is included as a control variable in my model, which is why I excluded it from my panel regression.

3.8 Explanatory Variables

Fed’s announcement
The announcements are my main experimental variable. My thesis is centered on how the March 23rd, and April 9th announcements effect the credit spread of the bonds that were qualified for the SMCCF. I controlled for both effects

Slope of the Yield curve
To put things in context, when the yield curve slope increases, it signals that the economy is strengthening, interest rates will rise in the future, and credit spreads will narrow. This link,
however, is not always consistent, since numerous research has yielded inconsistent results about the yield curve and spreads’ direction, which is most likely due to other factors in the research not included in the model. Nonetheless, the strong relationship between the yield curve and bond spreads is a finding that has been confirmed in several studies (Svetozar Jargic 2017), (Hussaini 2007).

Covid Outbreak
According to the CDC, the World Health Organization's International Health Regulation Emergency Committee reconvened on January 31st, 2020 and declared the coronavirus epidemic a Public Health Emergency of International Concern. Additionally, during that same period of time, Alex Azar the United States Secretary of Health and Human Services declared the SARS-CoV-2 virus a public health emergency, and the White House 2019 Novel Coronavirus Task Force announced the introduction of new travel regulations. CNN also warned the public on January 31st about Covid exposure in their news article titled “January 31 coronavirus news”. These events instilled dread and skepticism in the United States financial markets. I placed a dummy control for this time event as well.

Fed’s bond Purchase
On June 15, 2020, the New York Fed released a press release announcing the Secondary Market Corporate Credit Facility (SMCCF) would begin acquiring corporate bonds. Additionally, this was mentioned in the Secondary Market Corporate Credit Facility term sheet. As a result, I introduced a dummy variable for the Fed's purchase to account for time-specific fixed effects across firms in my panel data.
3.9 Covid Snapshot

My dependent variable was the spread, or difference, between the bond yields of SMCCF transportation corporations and equivalent maturities of US Treasury securities. I utilized the yields of the trades that were occurring in real-time to build a graph and shed light on the movement of yields throughout the period around the announcement and subsequent Federal Reserve purchases. My graph is based on the activities of bond trading. Therefore, if any of the bonds in my sample were not exchanged during the time of interest, I would be unable to gather any data for my research. This issue arose regularly during my investigation. JB Hunt Transport Services Inc, Burlington Northern Santa Fe LLC, Delta Air Lines Inc, CSX Corp, ERAC Finance USA LLC, FedEx Corporation, Kansas City Southern Corporation, Norfolk Southern Corporation, Penske Truck Leasing Company, and Ryder System Incorporated were among the bonds from the transportation sector included in the SMCCF. However, just nine issuer's bonds had sufficient trading activity from January to August 2020 to be included in my panel data and fixed-effect model, and these 9 issuers were Burlington Northern Santa Fe LLC, Delta Air Lines Inc, FedEx Corporation, Norfolk Southern Corporation, Penske Truck Leasing, Ryder System Corporation, Union Pacific Corporation, and United Parcel Service Corporation. The following table illustrates some of the companies’ bond spreads.
Figure 5: BNSF credit spread at the height of the announcement and the Fed’s purchase

credit spread of eligible BNSF railway and credit spread of non-eligible BNSF railway

Source: Own calculation based on TRACE/Finra & U.S Daily treasury rates
Figure 6: Delta credit spread at the height of the announcement and Fed’s purchase

Source: Own calculation based on Trade Finra & U.S Daily treasury rates

Figure 7: Fed Ex credit spread at the height of the announcement and Fed’s purchase

Source: Own calculation based on Trade Finra & U.S Daily treasury rates
Figure 8: United Parcel credit spread at the height of the announcement and Fed’s purchase

Credit spread of eligible United parcel and Credit spread of non-eligible united parcel

Source: Own calculation based on Trade Finra & U.S Daily treasury rates
These graphs are intended to provide a snapshot of the rates on these firms' bonds at the time of the announcements and the Fed's purchase. Due to inconsistencies and discrepancies in specific trades, I omitted months from the graphs that either had no trades or whose dates were irrelevant to my point. Additionally, I added bonds from the same qualified issuers that were not acquired directly by the Federal Reserve to compare their yields to those in the government's portfolio. One consistent feature across all graphs is the similar trajectory of eligible and non-eligible bonds throughout the announcements and purchases. Bin Wei, Simon Gilchrist, Yue Egon Zakrajek (2020) discovered that the Federal Reserve's influence on all the bonds they acquired had a positive spillover effect owing to investors' hopeful attitude. Thus, if we make deductions from these graphs, we can see that the Fed's direct involvement had an effect on other bonds in the secondary market not just through its announcement and purchase but also on investors' confidence in response to the Fed's actions.
4 Results of the SMCCF

4.1 Heterogeneity across the different transportation industries

While the transportation sector was one of the most impacted by Covid, the industry as a whole did not fare the same. For example, Burlington Northern Santa Fe, one of North America's largest freight railroads, continued to operate at a reduced capacity as goods needed to be transported throughout the economy, while consumer airline companies like Delta, whose primary business is the transportation of passengers, faced significant disruptions at the start of the pandemic, due to the precipitous decline in passenger air travel. This resulted in significant disruptions to their cash flow and accounting balances, as well as a wave of investor distrust, as the investors believed that the most impacted firms would struggle to repay interest on loan commitments. With that said, we see discrepancies and differences even between firms in the same sector, as demonstrated by Susan Holte and Stacey Mumbower (Ibid, 40) who explained that the impact of larger airports was significantly different from that of smaller airports during the pandemic, and the reason for this non-uniform impact was due to the CARES act's minimum service requirements, which allowed larger airports to inadvertently downsize to a larger scale relative to smaller airports. Therefore, the heterogeneity within the transportation industry is rather obvious, as seen by their bond's current yield to maturity. Increasing yields signal those bondholders would get additional interest payments, but they may also signify increased risk. Thus, a greater yield is viewed as an indication of desperation on the part of the issuer to convince investors to acquire their bonds. Lower rates are connected to stability and investor trust, which is why government bonds provide some of the lowest yields available in the financial market. Thus, in order to shed more insight on the disparities in the yields of the various issuers that participated in the SMCCF, I produced a graph illustrating the heterogeneity among the various firms. In the context of this research, heterogeneity refers to differences in bond spreads between the yields on these bonds from January to August 2020, and their mean. The figure is included below.
At first look, it's clear that Delta's bond spread is an aberration. The default risk is defined as the yield differential between the issuer's bonds and comparable-maturity US Treasury bonds. From this graph, we can see that between January and August, Delta traded at rates that were up to 15% higher than the US treasury. As a result, rates have to rise as high as 15% to entice investors in the bond market. Additionally, the red diamond shape represents the mean of the spreads on the different bonds from January to August 2020. I estimated the mean of these bonds to examine the spreads across the duration of the time period covered by this research, primarily to understand how their yields have diverged over the course of the Covid epidemic, the Federal Reserve's announcements, the purchase of bonds, and the general uncertainty of the market. As previously noted, there were insufficient trades for CSX Corp, TTX Corp, Southwest
Airlines, Kansas City, and Ryder System. This is why these businesses were excluded from my panel data and every chart in my methodology. Returning to the figure above, we see that firms such as United Parcel and BNSF remained relatively stable and liquid from January to August. BNSF's average yield traded from January to August 2020 was 0.9 percent, which is quite low in comparison to firms such as Delta, whose average traded yield over the US Treasury was up to 5%. To provide some context, BNSF's highest traded yield was 5.1 percent, which was about equal to delta's average traded rates from January to August 2020. BNSF received the most money and has the biggest index weight in the Federal Reserve's portfolio of all qualified issuers in its sector, while simultaneously being the most liquid and stable of all the other transportation firms in the SMCCF. These bond spreads accurately reflect the financial situation in which these corporations found themselves at the time. Delta is one of a number of companies that experienced major disruptions to their everyday consumer passenger flight operations. Volatility and high bond rates are indicative of their difficulties during this period. BNSF is a freight railway company, United Parcel Service is an American package and document delivery company with operations worldwide, Ryder is a logistics company, FedEx is a shipping and e-commerce company, Penske is a leasing company, and Norfolk and JB.transport all operate in the same line of business as the previously mentioned companies, and what they all had in common was their limited but continued operation during the pandemic's start. While limited capacity operations have their drawbacks, they are vastly preferable to a total shutdown, which Delta and Southwestern airlines experienced worse than any of these other enterprises. As a result, we can see that Delta had the most dispersion and volatility of any bond. However, to illustrate the time period during which these spreads occur, I plot the same graph but this time using the dates of my research from January to August as the X-axis. The illustration is provided below.
The graph above depicts the bond spreads of SMCCF transportation firms from January to August 2020. Similar to the graph above, which illustrates firm heterogeneity, we can observe that the largest outlier of all these firms is Delta. These figures demonstrate that Delta's spreads were extremely volatile, and most likely remain so to this day, in comparison to the other corporations in our research. These yield spreads can provide insight into these businesses' stability. From the beginning of January, the yields of all corporations moved in a constant and homogeneous manner; however, from March 1st, 2020, until the end of April, we witness the yields of these bonds diverge and become unpredictable. The yields on the same spreads stabilize in late July and early August. As a result, we discover that the Federal Reserve intervened at a period when investor trading of these bonds was inconsistent and volatile due to market concerns about the issuer's ability to repay its debt interest commitments. The bond
spreads following the Federal Reserve's involvement appear to have contributed to the restoration of faith in the bond secondary market. Nonetheless, enterprises such as Delta, whose bond ratings were downgraded by Moody's and S&P, and whose entire operation took a substantial hit, faced higher rates than most companies in their industries. Delta's high yield appeared to have occurred following the Federal Reserve's announcement of the SMCCF, indicating that the Federal Reserve's beneficial effect on reducing credit spreads on bonds in the SMCCF did not appear to be uniform across all issuers in this special purpose vehicle.

4.2 Empirical Model

My fixed effect model is as follows,

\[ CS_{i,j,t} = \beta_1 (r^{10} - r^2) + \beta_2 (1[t \geq t^c]) + \beta_3 (1[t \geq t^*]) + \beta_4 (1[t \geq t^{**})] + \beta_5 (1[t \geq t^{***})] \]
\[ + \alpha_t + \epsilon_{i,j,t} \]

Where

- \( CS_{i,j,t} \) is the dependent variable where \( i=\)entity, \( t=\)time, \( j=\)cusip (bond identifier), and
- \( \alpha_t \) \( (1, \ldots, n) \) is the unknown intercept for each entity (9 entity-specific intercepts), and
- \( (r^{10} - r^2) \) is the slope of the yield curve,
- \( (1[t \geq t^{***})] \) is the date of the Fed’s purchase initiation
- \( (1[t \geq t^{**})] \) is the April 9th announcement
- \( (1[t \geq t^{*})] \) is the march 23rd announcement
- \( \epsilon_{i,j,t} \) is the error term.

We will analyze the movements of bond spreads from the various transportation issuers part of the Secondary Market Corporate Credit Facility before and after the Federal Reserve’s announcement. This fixed effect model removes the effects of any time-invariant characteristics that is only unique to the firms in our model, and this will result in the net effect of the announcements on the bond spreads of various firms.
4.3 Panel Data Diagnostics

When generating a regression model from panel data (a combination of cross-sectional and time series), diagnostic testing is recommended for validation and confirmation that the estimates and hypothesis testing are accurate. In addition, diagnostics help detect any problems with model specifications. Oscar Torres-Reyna, in his review on panel data analysis, recommends most of these configurations when performing a panel data analysis. The major defects for this type of panel data model include heteroscedasticity, serial correlation, cross-sectional dependence/contemporaneous correlation, multicollinearity, and the use of correct effects. The statistical program I used for this research is Stata as it gave me the flexibility and ease to run all the diagnostics in my data and regression model. To start out, my first test was multicollinearity.

**Multicollinearity**

Multicollinearity happens when there is a strong relationship between the explanatory variables in our model. This model defect is not a major concern in panel data analysis since fixed-effect models control for multicollinearity because they are held constant with heterogeneous firms across our model. I used Variance Inflation Factor (VIF) test in Stata to detect any multicollinearity and the results were as follows
Table 3: Multicollinearity measurement among the explanatory variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>VIF</th>
<th>1/VIF</th>
</tr>
</thead>
<tbody>
<tr>
<td>r10r2</td>
<td>2.78</td>
<td>0.359900</td>
</tr>
<tr>
<td>March23th</td>
<td>4.75</td>
<td>0.210380</td>
</tr>
<tr>
<td>April9th</td>
<td>3.45</td>
<td>0.289996</td>
</tr>
<tr>
<td>FedPurchase</td>
<td>1.19</td>
<td>0.838049</td>
</tr>
<tr>
<td>Covidoutbr~k</td>
<td>1.44</td>
<td>0.692044</td>
</tr>
<tr>
<td>ID</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1.71</td>
<td>0.585694</td>
</tr>
<tr>
<td>3</td>
<td>1.48</td>
<td>0.676573</td>
</tr>
<tr>
<td>4</td>
<td>1.26</td>
<td>0.794625</td>
</tr>
<tr>
<td>5</td>
<td>1.25</td>
<td>0.802558</td>
</tr>
<tr>
<td>6</td>
<td>1.70</td>
<td>0.588077</td>
</tr>
<tr>
<td>7</td>
<td>1.54</td>
<td>0.649622</td>
</tr>
<tr>
<td>8</td>
<td>1.58</td>
<td>0.634606</td>
</tr>
<tr>
<td>9</td>
<td>1.66</td>
<td>0.603896</td>
</tr>
</tbody>
</table>

Mean VIF 1.98

Source: Author’s calculations

From the figure above we see that the explanatory variable in this model is not highly correlated, and this is because VIF ranges from 1 upwards. The higher the VIF, the less reliable the regression estimation. A value between 1 and 5 is moderately correlated and anything above 10 is a sign of worry. Ignoring the IDs, we see that the variables in the model do not exceed 5, so there is no real sign of concern. Next, I proceeded to examine for heteroscedasticity and autocorrelation.
Heteroscedasticity, and autocorrelation

To test for heteroscedasticity and autocorrelation I used the Modified Wald test for groupwise heteroskedasticity in the fixed effect regression model in Stata. The results are as follows.

Table 4: Modified Wald test for GroupWise heteroskedasticity

<table>
<thead>
<tr>
<th>Source</th>
<th>Modified Wald test for groupwise heteroskedasticity in fixed effect regression model</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>H0:</strong> $\sigma(i)^2 = \sigma^2$ for all $i$</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>chi2 (9)</th>
<th>6346.12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prob&gt;chi2</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

Source: Author’s calculation

As stated by Christopher F. Baum, the null hypothesis is $\sigma_i^2 = \sigma^2 \ \forall \ i = 1, ..., N_g$ is the number of cross-sectional units, or another way of saying this is the error process is homoscedastic with the variance being homogenous across units (Christopher F. Baum, 2001). So, with a p-value being 0, and less than the significance value of 5% we reject the null hypothesis of homoscedastic and conclude that my model has heteroskedasticity. I then proceeded to test for serial correlation, a necessary diagnostic for panel regression mentioned by multiple authors such as Oscar Torres-Reyna.

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3 During my research and coding’s in Stata, I used both OLS n-1 dummy regression model with a constant, and the fixed effect regression model with entity specific intercept that captures the heterogeneity across the different transportation firms when running my diagnostics but only introduced the latter in this paper. Both regression models are equivalent and give the same estimation. This is important because when testing for my model defects in Stata, certain diagnostics are tailored to certain type of models. One example is my test for multicollinearity, i.e., VIF which was only possible after running the OLS dummy model, and this why you see the different firms ID as part of my multicollinearity calculation.
Serial correlation tests apply to macro panels with long time series (over 20-30 years). Not a problem in micro panels (with very few years). Serial correlation causes the standard errors of the coefficients to be smaller than they actually are and higher R-squared (Oscar Torres-Reyna, 2007).

My model results follow,

**Table 5: Wooldridge test for autocorrelation in panel data**

```
. xtserial Defaultrisk r10r2 March23th April9th Covidoutbreak FedPurchase
```

<table>
<thead>
<tr>
<th>Wooldridge test for autocorrelation in panel data</th>
</tr>
</thead>
<tbody>
<tr>
<td>H0: no first-order autocorrelation</td>
</tr>
<tr>
<td>(F(1, 8) = 14.878)</td>
</tr>
<tr>
<td>Prob &gt; F = 0.0048</td>
</tr>
</tbody>
</table>

**Source:** Author’s calculations

The null hypothesis is that there is no first-order autocorrelation. With a p-value below 5%, we reject the null hypothesis and conclude that there is autocorrelation in the model. The best way to adjust for this is to obtain heteroskedasticity and autocorrelation robust standard errors. Daniel Hoechle in “Robust Standard Errors for Panel Regressions with Cross-Sectional Dependence”, brought to light the Driscoll and Kraay standard errors. In particular, Daniel Hoechle mentions that

fe performs fixed-effects (within) regression with Driscoll and Kraay standard errors. These standard errors are heteroscedasticity consistent and robust to very general forms of cross-sectional (“spatial”) and temporal dependence when the time dimension becomes large. If the residuals are assumed to be heteroscedastic only, use xtreg, fe robust. When the standard errors should be heteroscedasticity and autocorrelation consistent, use xtreg, fe cluster ()..

(Daniel Hoechle 2007, 6)

I, therefore, proceeded to use the Driscoll and Kraay standard errors to adjust for the problems of heteroscedasticity, and autocorrelation. I then compared those results to my regression model without the adjustment of standard errors.
Cross-sectional dependence

As stated by Daniel Hoechle these standard errors do not only adjust for heteroscedasticity, and autocorrelation but also for general forms of cross-sectional and temporal dependence. Nonetheless, I proceeded to check if my model had cross-sectional dependence as this can also lead to bias results in the estimation of the model. This test was done using Pasaran’s CD test for cross-sectional independence in Stata. The null hypothesis is that there is no cross-sectional dependence, and the alternate hypothesis is that there is cross-sectional dependence. The results of my model are shown below,

Table 6: Pesaran’s test of cross-sectional independence

| Pesaran's test of cross sectional independence = | 26.463, Pr = 0.0000 |
| Average absolute value of the off-diagonal elements = | 0.582 |

Source: Author’s calculation

Based on these results with a p-value below the significant level of 5% we can conclude that my model does have some form of cross-sectional dependence within the different firms in this research. So, from the diagnostics performed we see that the variability of the credit spreads of the different transportation firms is not equal nor consistent across the independent variables in my model, nor is it equal towards both Federal Reserve’s announcements. This makes sense when looking at the different bond spreads because firms like Delta were trading at yields far greater than any other firms in this research thereby increasing the possibilities of outliers (or variability). In regard to autocorrelation, it would
make sense for this to be a problem in the model because I’m studying the financial markets at past and present yields whose performances affect investors’ perception of future yields. Luckily the Driscoll and Kraay standard errors adjust for these discrepancies.

**Limits of the Unit Root test**

One other diagnostic that is popular among panel data sets is the unit-roots test. There are multiple tests in Stata that conduct the presence of unit roots such as (The Levin–Lin–Chu 2002), (Harris–Tzavalis 1999), (Breitung 2000; Breitung and Das 2005), (Im–Pesaran–Shin 2003), and Fisher-type (Choi 2001) tests with a null hypothesis that there is a unit root (Panel-data unit root tests/Stata.com, 2004). However, the majority of these tests are only possible with a balanced panel dataset, a prerequisite that my data does not have. As stated before, the information in my data is based on the yields that were traded for that day. Unfortunately, not every bond of the firms in my research had consistent bond trades from January to August 2020, thereby making my panel data unbalanced, and ineligible to conduct the unit root tests.

### 4.4 Data Results

I did a similar study on bonds that were not acquired by the Federal Reserves in the SMCCF but were from the same qualified transportation issuers to examine any substantial difference between the yields not acquired by the Federal Reserve and the yield of bonds in the Federal Reserve's portfolio. To remove biases and acquire the most reliable results, I also conducted a similar diagnostics model on the ineligible bonds of this study. The results are shown below,
Table 7: Fixed effect model Data results

<table>
<thead>
<tr>
<th>Source</th>
<th>EligFixed b/se</th>
<th>EligClusters b/se</th>
<th>Non EligFixed b/se</th>
<th>Non EligClusters b/se</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eligible fixed is my initial fixed effect model (composed of the bonds in the Federal Reserve’s portfolio) without adjusting for robust standard errors, and the column next to that model, Eligible clusters is my fixed-effect model adjusted for Driscoll and Kraay standard errors. Similarly, the column that reads non-eligible fixed is my fixed effect model of bonds not included in the Federal Reserve’s portfolio without the adjustment for standard errors, and non-eligible clusters are my fixed effect model of bonds not included in the Federal Reserve’s portfolio adjusted for standard errors. One big observation is that the March 23rd announcement reduces in significance when adjusted for standard errors, similarity the dummy variable of the Federal Reserve’s purchase saw a reduction of 1% significance level to 10% significance level</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
when adjusting the standard errors. We can also see that Driscoll and Kraay's standard errors tend to lead to an increase in standard errors as seen by the parenthesis under the estimation. So, one conclusion we can make from this is that model defects such as autocorrelation, and heteroscedasticity improperly overvalued the estimates given to our explanatory variables.

In addition, we see that the April 9th announcement had a significant contribution to reducing the spread of both the bonds in the Federal Reserve’s portfolio and the bonds that were not in the Federal Reserve’s portfolio. For the bonds in the Federal Reserve's portfolio, there were 156 drop-in basis points of the trades (in yield to maturity) of the transportation sector that were conducted after the Federal Reserve’s announcement. For the bonds outside of the Federal Reserve’s portfolio, the yields of their bond trades after the Federal Reserve’s announcement drop to 123 basis points.

The start of the Federal Reserve’s purchase on June 16th also further led to the reduction of the bonds that were in the Federal Reserve’s portfolio and the bonds that were not part of the Federal Reserve’s portfolio, 91 basis points, and 85 basis points respectively. The estimation that may stand out to most people is how it was possible for bond yield to increase after the March 23rd announcement, and introduction of the SMCCF. Authors Simon Gilchrist, Bin Wei, Vivian Yue, and Egon Zakrajsek (2020) in their analysis of the SMCCF found that bonds in the SMCCF issued as fallen angels had an increase of 340 basis points relative to the bonds that were not eligible for the SMCCF during the March 23rd announcement. One big reason why this could be the case in the bonds in my research is that multiple issuers from multiple sectors had credit ratings that may not have had them qualify for the initial onset of the SMCCF when the government set the funding for high rating investment-grade bonds. With that said not every issuer from the transportation sector initially qualified for the March 23rd announcements. There are different forms of bond ratings from S&P ratings, to Moody’s, to Trade Grade ratings. Since my dataset is composed of information from Finra, I constructed a chart of issuers in my research who at that moment time had bonds that would not have qualified for the SMCCF during the March 23rd announcement due to their low ratings and high yielding characteristics.
Table 8: Trace Grade Ratings

<table>
<thead>
<tr>
<th>Trade Grade</th>
<th>March 23rd (Strictly investment grade)</th>
<th>April 9th (Expansion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NORFOLK SOUTHN CORP</td>
<td>Delta</td>
<td></td>
</tr>
<tr>
<td>UNITED PARCEL SVC INC</td>
<td>FedEx</td>
<td></td>
</tr>
<tr>
<td>UNION PAC CORP</td>
<td>Penske Truck</td>
<td></td>
</tr>
<tr>
<td>RYDER SYS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>J B TRANS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BURLINGTON NORTHN</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: author's table based on TRACE bond rating

From this, we can see that firms like Delta and Penske Truck could have driven up the overall spread in the March 23rd announcement due to their low credit ratings and ineligibility status. Nonetheless, the April 9th announcement drastically improved the liquidity for the transportation sector with a significant reduction of the trades of bond yields.
5.1 Implication and limitations

The purpose of this study is to evaluate the impact of the Federal Reserve's announcement and subsequent purchase of a chosen US transportation corporate bond in the SMCCF. I developed a fixed effect model of companies from the transportation sector included in the SMCCF and followed the yields on their bonds from January to August 2020 to see if their spreads have improved as a result of the Federal Reserve's operations. Previous authors examined the SMCCF in its entirety utilizing tens of thousands of bonds. My research differs in that I go in-depth with the spreads of some of the industries and firms severely afflicted by the pandemic using charts and graphs, and a panel regression model. Throughout my analysis, I've discovered a clear distinction between corporations like BNSF, who received the most federal assistance (in the transportation category), combined with a stable low yielding bond spread, and Delta a firm whose cash flow and operations were significantly disrupted by Covid's travel restrictions, coupled with a volatile and explosive bond spread. Their bond spreads tell a story, which is what my thesis attempts to achieve.

According to my results, the March 23rd announcement on eligible bonds resulted in an increase in credit spread relative to the yields that those bonds were trading at before the March 23rd announcement, potentially as a result of the credit rating drop and eligibility status of those bonds, but this adjusted by the time the April 9th announcement came about. Additionally, we also see that the Federal Reserve’s announcement had a greater effect on reducing the yields of the bonds than the actual purchases. The overall value of the SMCCF portfolio peaked at roughly 14 billion, despite the fact that the SMCCF was permitted to acquire up to 250 billion in corporate bonds, so SMCCF's extreme leverage was unnecessary and could have been used elsewhere, but one thing we can see is that the Federal Reserve’s impact on the secondary corporate bond market was a positive one.
Bibliography


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Appendix A: Credit spread of Eligible Norfolk Southern Corp

Figure 12: Credit Spread of eligible Norfolk Southern Corp

Source: Own illustrations, Data: finra-markets.morningstar.com 2020
Appendix B: Credit spread of non-Eligible Norfolk Southern Corp

Figure 13 Credit Spread of non-eligible Norfolk Southern Corp

Source: Own illustrations, Data: finra-markets.morningstar.com, 2020
Appendix C: Credit spread of Eligible Penske Truck Leasing

Figure 14 Credit Spread of eligible Penske Truck leasing

Source: Own illustrations, Data: finra-markets.morningstar.com 2020
Appendix D: Credit spread of Eligible CSX CORP

Figure 15 Credit Spread of eligible csx corp

Source: Own illustrations, Data: finra-markets.morningstar.com 2020
Appendix E: Credit spread of Union Pacific Corp

Figure 16 Credit Spread of eligible Norfolk Southern Corp

Source: Own illustrations, Data: finra-markets.morningstar.com 2020
Appendix F: Credit spread of Union Pacific Corp

Figure 17 Credit Spread of non-eligible Union Pacific

Source: Own illustrations, Data: finra-markets.morningstar.com 2020
Appendix G: Credit spread of non-eligible Penske Truck Leasing

Figure 18 Credit Spread of non-eligible Penske Truck Leasing

Source: Own illustrations, Data: finra-markets.morningstar.com 2020
Appendix H: Credit spread of eligible Ryder system

Figure 19 Credit Spread of eligible Ryder system

Source: Own illustrations, Data: finra-markets.morningstar.com 2020
Appendix I: Credit spread of eligible and non-eligible JB transport

Figure 20 Credit Spread of eligible and non-eligible JB Transport

Source: Own illustrations, Data: finra-markets.morningstar.com 2020
Appendix J: Credit spread of eligible TTX CO bond

Figure 21 Credit Spread of eligible TTX CO bond

Source: Own illustrations, Data: finra-markets.morningstar.com 2020
Appendix K: Credit spread of non-eligible Southwest Airlines

Figure 22 Credit Spread of non-eligible Southwest Airlines credit spread

Source: Own illustrations, Data: finra-markets.morningstar.com 2020