2011

The Effect of the Introduction of a Clearinghouse on Trading Costs: The New York Stock Exchange in the 1890s

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SUBMITTED TO

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FOR

SENIOR THESIS

FALL 2011

November 28, 2011

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Acknowledgements

First and foremost, I would like to thank Professor Hughson for his guidance and support in writing my thesis. I would also like to thank Professor Weidenmeier and Emily Case for their insight, which was crucial to my thesis. In addition, I would like to thank the Financial Economics Institute, in particular Terri VanEaton, for the excellent working conditions and snacks that I benefited from while working on my thesis. I would also like to acknowledge Noah Franz for his feedback in helping to edit my thesis. Most importantly, I want to thank my parents and friends for their love and support.

Abstract

As one of the oldest and most innovative financial institutions, a clearinghouse efficiently clears and settles payments for equity transactions as well as other securities. However, this paper will only be concerned with common and preferred equity securities. The purpose of a clearinghouse is to reduce counterparty risk. It acts as an intermediary between two parties, so that the risk of one party failing to honor its contractual obligation is diminished. It reduces settlement risk through netting, the process of eliminating offsetting transactions, thus decreasing the amount of cash flow. I examine the impact of the New York Stock Exchange Clearinghouse upon its establishment in May 1892. Specifically, I analyze the clearinghouse's effect on trading costs for different equity securities, scrutinizing the effects on bid-ask spreads. I find that once a firm joined the NYSE clearinghouse, both its relative and absolute bid-ask spreads are narrowed, representing an overall reduction in spreads of 5.28 percent.

I. Introduction

A clearinghouse is defined as an agency on an exchange that settles transactions for a commission rate, delivers and reports trading activity, clears trades, and collects and manages margin monies. By consolidating and organizing certain types of financial transactions, a clearinghouse diminishes the transaction costs and operation risks of clearing and settling among brokers and traders (Bernanke 2011). Additionally, a clearinghouse functions as a guarantor of transactions, a counterparty to each trade, which mitigates liquidity and counterparty credit risks (Bernanke 2011). As a result, idiosyncratic risk is reduced because the clearinghouse takes on the default risk of market participants.

A major benefit of the introduction of a clearinghouse is the concept of netting. The netting process consolidates inter-party transactions and calculates settlement requirements internally rather than using external payment methods. By netting, market participants reduce cash flow, commission rate, and clearinghouse balances and also enhance operating efficiency by streamlining the process through decreasing the number of open contracts. With increasing economies of scale, each contract is offset through multilateral netting. A market participant's trading gains and losses are accumulated and netted across all transactions. For instance, suppose that Firm A owes Firm B $500 and Firm B owes Firm C $1,000. Instead of executing these three transactions, netting reduces cash flow by simply having Firm A pay Firm C $500 (Noyes 1893). Applying this example to a clearinghouse, it implements multilateral netting rather than executing a complicated web of transactions between market participants, which reduces the number of transactions and minimizes risk. Ultimately, a clearinghouse is responsible for the payment and delivery of the trading day's final balance of net credits and debits (Richter 1920).

Recently, there has been much discussion in popular press about instituting a clearinghouse in the Credit Default Swaps (CDS) market because one of the main elements in the new regulatory approach, Dodd-Frank, is to stabilize the derivatives market. It is widely acknowledged that the credit crisis of 2008 was due to extremely high levels of counterparty risk, which is the risk that either a buyer or seller will fail to meet its contractual obligations, within the CDS market (Bliss and Papathanassiou 2006). The highly interconnected and fragile CDS financial market caused a domino effect throughout financial institutions and led to the ultimate demise and solvency crisis of large financial institutions, such as Lehman Brothers and Bear Sterns. Many government officials and academics, including Darrell Duffie, Raghuram G. Rajan, Robert J. Shiller, Kenneth R. French, to name a few, support the idea of implementing a clearinghouse in the CDS market (Squam *et al.* 2009). A central clearinghouse counterparty (CCP) would act as an intermediary between over-the-counter (OTC) derivatives counterparties by insulating them from the possibility that either one would default.

Duffie and Zhou (2010) examine in "Does a Central Clearing Counterparty Reduce Counterparty Risk?", whether the central clearing of a particular class of derivatives, in this case the CDS market, reduces counterparty default. The paper finds that effective clearing reduces systematic risk by diminishing the possibility that defaults propagate from one party to the next. The analysis reveals that the introduction of a CCP for standard credit derivatives is only effective in multilateral netting, not bilateral netting. According to Duffie *et al.*'s analysis, a CCP eliminates the benefits of bilateral netting and in fact, increases the exposure between the two counterparties. Nevertheless, Duffie *et al.* posit that the introduction of a CCP for the CDS market is advantageous for multilateral netting. Duffie *et al.* argue that the same CCP that clears CDS could also clear interest-rate swaps. The authors suggest a joint clearing because the interoperability of CCPs will achieve extensive reductions in counterparty risk (Duffie *et al.* 2010).

Although theoretically, Duffie *et al.*'s analysis indicates that a clearinghouse might reduce transaction costs through a reduction in counterparty risk, it is not easy to analyze empirically, the effect of adding a clearinghouse to an existing market. Indeed, most major exchanges have had clearinghouses for over eighty years. Fortunately, history provides an instance where trading costs can be examined both before and after the institution of a clearinghouse – the case of the NYSE in the 1890s. Furthermore, firms did not all join the clearinghouse simultaneously. As a result, the effects of contaminating events, which may have occurred during the same time firms join the clearinghouse, are minimized.

Why does a clearinghouse reduce trading costs for market makers? One reason is because of netting, which requires market makers to hold less cash than if netting were not implemented. That is, netting reduces the inventory costs of market making (see e.g. Stoll 1989). To the extent that market makers compete, this savings should be passed along to traders in the form of lower bid-ask spreads. Conversely, spreads should be higher for the same stocks pre-clearinghouse. This is the proposition I test: that bid-ask spreads fall when a firm joins a clearinghouse. Consistent with my hypothesis, controlling for other known determinants of the bid-ask spread such as volume, size, volatility, and interest rates, the introduction of a clearinghouse reduces trading costs by a statistically significant amount. The economic size of the effect is also significant. I find that median relative spreads fall from 90 basis points ($9.00 on a $100 investment) to 85. In absolute terms, the median spreads fall from $0.37 to $0.348. This represents an overall reduction in spreads by approximately 5.28 percent.

Although there has been a substantial amount of literature written about the determinants of transaction costs, to our knowledge, there is little literature on the empirical effect on transaction costs of adding a clearinghouse to a market where one did not previously exist. This is the focus of our paper. Our hypothesis is that the establishment of the NYSE clearinghouse narrowed spreads due a reduction in inventory holding costs (Stoll 1989). To better determine the effect of the clearinghouse, I control for other variables that have been shown to affect bid-ask spreads in other contexts, such as competition between the NYSE and the Consolidated Stock Exchange (see e.g. Brown, Mulherin and Weidenmier 2007), daily volatility of stock prices, securities' trading volumes and closing stock prices. I analyze daily data from the NYSE and the Consolidated Stock Exchanges between 1893 and 1900, seven years worth of data since the inception of the NYSE clearinghouse. I predict, that controlling for overall market conditions, the creation of the NYSE clearinghouse will cause bid-ask spreads to decrease.

This paper proceeds as follows: Section II examines the history of clearinghouses. Section III reviews academic literature on the role of clearinghouses and its effects on bid-ask spreads. Section IV describes the collection and use of the data. Section V presents and analyzes the results of my empirical model and discusses the implications of my results. Section VI concludes the paper and offers areas for potential future studies.

II. History of Clearinghouses

A parsimonious, simple system of clearing has existed since the Middle Ages. During the nineteenth century, clearinghouses were typically used by banks as a method to clear checks and settle accounts. The first official clearinghouse to go beyond clearing bank obligations was established in May 1867 when the Handelskammer, the exchange in Frankfurt, Germany, created its own clearinghouse (Noyes 1893). Its purpose was to trade government securities, specifically the United States bonds. Subsequently, this system was adopted in the Berlin, Hamburg, Vienna, and London exchanges in 1869, 1870, 1873, and 1876, respectively (Noyes 1893).

May 17, 1892 marked not only the centennial of the Buttonwood Agreement, but also the creation of a clearinghouse for equity securities of all types: the New York Stock Exchange (NYSE) (Bernanke 2011). The primary purpose of the NYSE clearinghouse was to centralize trading activity and reduce the amount of cash flow per transaction. In fact, the clearing system reduced the average daily percentage of clearinghouse balances to total transactions by approximately four to five percent (Noyes 1893). Under the rules of the exchange, all deliveries of daily trading transactions had to be delivered by 2:15pm (Richter 1920). Since business transactions on Saturdays ended at noon, operations on Mondays were adjusted for both Friday and Saturday. Once all the deliveries were received, each transaction was recorded on a clearing sheet, illustrating the number of a firm's shares that were bought or sold, the broker's names, and the price of the stock. This clearing sheet was then sent to the Clearinghouse, where all exchange tickets were settled.

The NYSE Clearinghouse imposed strict rules on its members. Originally, firms were granted membership by the Clearinghouse Committee based on liquidity. According to Article III, Section 3 of the Constitution of the New York Clearinghouse Association, a new member could join the exchange by a vote of three-fourths of the Clearinghouse Committee. Furthermore, Article IV states that a corporation whose market value was less than $5 million would pay an admission fee of $5,000 and those who exceeded $5 million would be required to pay $7,500. In addition, members had to pay 2 ½ cents per each 100 shares cleared that had a par value of $100 in order to cover the expenses of the exchange. In its first few days of trading, only four railroad companies traded on the exchange: Chicago, Milwaukee & St. Paul; Louisville & Nashville; Northern Pacific preferred; and Philadelphia & Reading (Richter 1920). As the exchange grew rapidly in size, more firms were admitted as members so that the exchange was soon clearing the most liquid stocks. It should be noted, however, that not every firm, even in New York, was a member of the exchange.

Technological innovations and globalization gave rise to a number of competitors, most notably, the Consolidated Stock Exchange of New York (Consolidated), which challenged the NYSE dominance in the financial markets. The establishment of the transatlantic cable, the ticker, and the telephone, in 1866, 1867 and 1878, respectively, had created a financial environment that was rife with expansion, success and vicissitude (Michie 1986). These new technological innovations enabled competition between stock exchanges. In particular, the rivalry between the Consolidated, or the "Little Board," and the NYSE, the "Big Board," emerged during this time. In 1885, the Consolidated had been formed by the merger of the New York Mining Stock Exchange, the New York Petroleum Exchange and the National Petroleum Exchange (Brown *et al.* 2008). This competition between the two exchanges lasted 42 years, from 1885 to 1926 (Brown *et al.* 2008).

During this period from 1885 to 1926, the Consolidated traded the most liquid stocks on the NYSE. Over the course of the rivalry, the Consolidated traded 23 percent of the NYSE trading volume (Brown *et al.* 2008). The Consolidated offered odd-lot trading, less than one hundred shares, in addition to a longer settlement period as compared to the NYSE (Brown *et al.* 2008). Furthermore, the Consolidated charged a commission rate of 1/16, undercutting the NYSE's commission as it was only allowed to charge a minimum tick of 1/8 due to a rule restricting further reduction (Michie 1986). As a result, the NYSE imposed a rule on its members forbidding them to trade with the Consolidated. The NYSE tried to create artificial barriers, preventing the Consolidated from having access to current market prices by removing their ticker from the exchange (Michie 1986). However, due to technological advancements, third party brokers and dealers who had access to information on the NYSE would share information with the Consolidated, as to avoid paying the high commission fees of the NYSE (Michie 1986). The increased competition resulted in a reduction in bid-ask spreads (Brown *et al.* 2008).

III. Literature Review

Many academics conclude that the determinants of bid-ask spreads are comprised of trading volume (Demsetz 1968) , volatility (Bollen *et al.* 1992) and closing price (Bollen *et al.* 2004). In the academic literature, there are three reasons given for the existence of bid-ask spreads on a stock exchange: asymmetric information, monopoly power, and an inventory holding premium.

The fundamental idea behind adverse selection as a reason for a bid-ask spread is that the market maker does not know whether a customer, who wants to trade, possesses information that is superior to that of the market maker. Without a spread, a competitive market maker would break even facing an uninformed trader but would necessarily lose to an informed trader, who would buy if the single price set by the market maker was too low, and would sell (or sell short) if the single price set by the market maker was too high. Hence, the only way for the market maker to profit, or at least break even, is to charge a higher ask price than a bid price. That is, there must exist a bid-ask spread. This argument was first formalized by Copeland and Galai

(1983), Glosten and Milgrom (1985), and Kyle (1985). In these papers, the market maker charges a higher price to buyers then he is willing to pay sellers, and because the market makers in these models are assumed to be competitive, they break even on average, making up from the uninformed traders what they lose to the informed. This basic insight remains whether uninformed traders are strictly "noise" traders, who trade regardless of the prices they face or whether the uninformed traders are price-sensitive, so that they buy (sell) smaller amounts when the ask price is higher (the bid price is lower). In addition, Kyle (1985) shows that the same insight holds in a dynamic context.[1]

Brown, Mulherin, and Weidenmier (2008) empirically analyze the effect of monopoly power on spreads, specifically examining the rivalry between the Consolidated Stock Exchange of New York and the NYSE between 1885 and 1926. As trading volumes began to grow during the late 1880s and early 1890s, the number of security listings on the NYSE increased. From 1875 to 1884, the quantity of NYSE security listings doubled (Brown *et al.* 2008). The NYSE's liquidity was negatively impacted by the Consolidated as the Consolidated tended to trade the most liquid NYSE listings. In turn, the most liquid securities that traded on both exchanges tended to trade at a minimum bid-ask spread, or 1/8, which further provides evidence of the Consolidated-effect on the NYSE. The authors empirically investigate the effect of the Consolidated on the NYSE by examining the bid-ask spreads before and after the rivalry began. They explore how NYSE bid-ask spreads are affected by the establishment of the Consolidated

[1] Kyle creates a model of insider trading with chronological auctions, in order to analyze the liquidity of a provisional market, the informational content of prices, and the quality of insider information. In the model, he includes three different kinds of traders: a single risk-neutral trader, a competitive risk neutral trader and random noise traders (Kyle 1985). According to the results, a trader who possesses private information maximizes his profits in a dynamic market, meaning that noise trading hides his transactions from other liquidity traders. Moreover, as the time interval between auctions reaches zero, the asymmetric information becomes incorporated in the closing price of a security.

Stock Exchange in 1885. They calculate spread as either the natural logarithm of the absolute spread or the natural log of the relative spread of the security for that particular day. The linear regression controls for the security's price, trading activity and return volatility (Brown *et al.* 2008). Also, the researchers controlled for market conditions by using broker call loan interest rate, consolidation of trading activity and the aggregate NYSE activity. They also included quarterly time dummies to control for any trend in the spreads. The analysis validates the hypothesis that the bid-ask spread dramatically narrows upon the creation of the Consolidated. In fact, the onset of the rivalry can account for a 10 percent reduction in the NYSE bid-ask spreads (Brown *et al.* 2008). Moreover, the competition between the two exchanges increased investors' returns because the transaction costs had been reduced.

Stoll (1978a) examines the effect of the inventory holding model on spreads. Dealers of immediacy, who post bid and ask prices, are ready to incur inventory and to assume the risk embedded with holding the inventory (Stoll 1978a). By appropriate changes in the dealer's bid-ask quotations, he influences the public market transactions so that his portfolio rebalances (Stoll 1978a). Under the inventory cost model, the realized spread earned by the dealer is less than the quoted spread by the dealer. This is due to the fact that the dealer lowers both bid and ask prices after he has purchased a security and increases both bid and ask prices after he sells, which causes inventory to be equilibrated (Stoll 1978a). Accordingly, if spreads reflect inventory holding premiums, then the dealer changes the price of the spread to the relative true price so that the public transaction will rebalance his own inventory (Stoll 1978a). In essence, the inventory cost model is symmetrical because price changes are symmetrical. Stoll reports that the inventory holding premium is dependent on the dollar amount for the transaction, the size of the dealer's initial holding, volatility, and the stock's return (Stoll 1978a). Stoll concludes that the spreads reflect the inventory cost because the quote prices are adjusted to induce trading as to offset the dealer's holdings, making his portfolio balance.

In accordance, Stoll and Ho (1981) stress the relationship between the spreads and the inventory holding model. This analysis extends the analysis of Stoll (1978a) to include uncertainty, primarily the introduction of transaction uncertainty. The authors analyze the difference between the true underlying price as determined by public information and transaction prices. They also examine the relationship between the quoted distributions of returns and the true distribution. Stoll *et al.* draws on an example of a single dealer who trades a single stock to explain the inventory holding premium. They model the inventory holding cost as an option with a stochastic time to expiration (Stoll *et al.* 1981). The dealer's inventory consists of the shares of that one particular stock. The fluctuations in the value of the security reflect the transaction uncertainty and the risk of holding that inventory. The inventory holding premium is reflected in the bid-ask spread because the dealer sets the spread without the knowing whether the next transaction will be to either buy or sell the stock (Stoll *et al.* 1981). As inventory rises, the bid and ask prices narrow and the opposite holds true for when inventory falls (Stoll *et al.* 1981). Stoll *et al.* conclude that the dealer equally changes the bid-ask spread when there is a change in a security's inventory.

Together, these studies address many questions about the determinants of bid-ask spreads. In our paper, we ask whether clearinghouses also affect bid-ask spreads in an economically meaningful way. Hence, it is important for our analysis of the effect of the addition of a clearinghouse on transaction costs to control for those variables others have previously found to influence spreads.

IV. Data

We collected daily data for NYSE and Consolidated stocks from the historical issues of the New York Times between 1892 and 1902. Approximately 100 firms entered or exited the NYSE clearinghouse following the ten years of its creation. As the New York Times only began publishing the bid and ask prices on May 14th, 1893, I do not have the bid and ask prices before this date; so my sample size includes 30 companies as displayed in Table 1. Therefore, while my initial time period was between 1892 and 1902, my time period was narrowed to 1893 to 1900. During this time period, I analyzed the stocks 50 days before they joined the clearinghouse and 50 days afterwards. Because each data point was input by hand, the scope of the data may have been affected.

In all of my regressions, the dependent variable is the bid-ask spread. The most important explanatory variable is the NYSE Clearinghouse dummy, which takes a value of zero for the 50 days before the firm joined the clearinghouse and a value of one for the 50 days after the firm joined. Based on the inventory holding model, I anticipate that this variable should have a negative coefficient meaning that once a firm joins the clearinghouse, its spread falls. It is also important to control for variables that others have found to affect bid-ask spreads.

The first control variable is the broker call loan interest rate, which is calculated in weekly terms. The broker call rate is included to measure the transaction cost, or the cost of holding an inventory of stocks. The weekly broker call rate adds to trading costs in this way: if a market maker must borrow money to operate a market, either to hold securities or to write checks, he borrows at the call loan rate. When that rate is high, so are the costs of operating a market, and to the extent that the market maker can pass these costs along to traders, spreads must rise. I anticipate that the broker call rate and the spreads will move together, meaning that as the broker call rate increases the spreads will increase too and vice versa.

Another control variable is share, which I calculate as the ratio of a security's NYSE volume to its Consolidated volume. This variable controls for the Consolidated only making markets in the most liquid NYSE securities and captures some notion of competition between the two exchanges. I predict that the variable's coefficient will be negative, meaning that as competition increases, spreads will narrow. I have also included in my regression a Consolidated dummy, which takes a value of zero if the security is *not* being traded on the Consolidated and a value of one if it is being traded. Similar to share, this variable captures the competition between the two exchanges. Monthly time dummies are also included to control for a trend in bid-ask spreads. All three of these variables have been proven to affect bid-ask spreads as seen in Brown *et al.*'s paper.

Next, I incorporate price return in my regressions to determine how the risk of holding a stock changes depending on the price return. An investor who expects a greater return typically has a greater risk appetite as compared to a market maker who desires a smaller return because of lower risks. As the level of risk diminishes, a security's return becomes steadier and unpredictable price fluctuations decrease. That being said, however, it is unclear how much price returns will affect serial covariance as serial covariance is already affected by the other control variables. I also calculated the standard deviation of each firm in order to capture market volatility. Volatility is a measure of asymmetric information and has been shown to affect spreads in other studies as mentioned earlier. I predict that each security's volatility as well as the average pooled level of volatility in the post-Clearinghouse period will significantly decrease in comparison to the period before entering the clearinghouse.

For each day, I collect data on daily closing prices, bid-ask spreads and trading volumes. I predict that the higher the closing price, the wider the spreads, which will balance the transaction costs. If relative spreads are held constant across securities, the absolute spreads will rise with the closing price. This means that I will want to include the closing price in the absolute spread regression, but it is not clear whether or not the closing price should be included in the relative spread regression.

It has been shown as far back as Demsetz (1968) that volume increases with trading costs. Therefore, I expect a correlation between increasing trading volumes and decreasing spreads because the NYSE centralized trading, which results in lowering transaction costs.

It is important to note that firms entered and exited the NYSE clearinghouse at different times and so firm-specific effects and external factors, such as the unemployment rate or the real level of gross domestic product, do not need to be controlled.

By examining data on 30 NYSE stocks during different time intervals over a period of seven years, any results that are seen in aggregate can be attributed to the introduction of the NYSE clearinghouse, as this would be the only substantial variable that all stocks had in common. For instance, if every firm joined the NYSE clearinghouse on May 17,1892 and if every bid-ask spread fell on that day, then it would not be possible to determine if the fall in the spread was due to the clearinghouse or to a contemporaneous event.

I excluded from my dataset anything that would be considered bias, such as a spread that is too big, which might have skewed my results. I define an outlier spread as a spread that is greater than four times the standard deviation of the size of a security's spread.

V. Results and Analysis

I now investigate the effect of the NYSE clearinghouse on securities' bid-ask spread. The bid-ask spread will incorporate any changes in market efficiency because spreads represent the difference between the lowest price a seller is asking for and the highest price a buyer is willing to pay. Best ask must always exceed best bid; otherwise the trade would be immediately netted. In essence, the spread represents the trader's gross profit for executing those trades. As transaction costs decrease, spreads narrow because traders are able to execute an order more efficiently and rapidly. In order to support the hypothesis that a clearinghouse impacts transaction costs, it is important to include additional explanatory variables, control variables, and dummy variables, as mentioned in Section III.

Each of my regressions have the following form:

$$\text{SPREAD}_{it} = \alpha_\text{i} + \beta_{1\text{i}}\text{VOL}_{it} + \beta_2\text{CLOSE}_{it} + \beta_3\text{STDEV}_{it} + \beta_4\text{SHARE}_{it} + \beta_5\text{CALL}_{it} + \beta_6\text{RETURN}_{it} + \beta_7\text{CH}_{it} + \beta_8\text{SHARE}_{it} * \text{CH}_{it} + \beta_9\text{CONS}_{it} + \beta_{10}\text{MONTH}_{it} + \varepsilon_{it}$$

For each firm, the dependent variable, SPREAD_{it}, is calculated as either the natural logarithm of the absolute bid-ask spread, $\ln|ask_{it} - bid_{it}|$, the ask minus the bid, or the natural log of the relative spread , $ln\left(\frac{ask_{it}-bid_{it}}{\frac{ask_{it}+bid_{it}}{2}}\right)$. The main variable of interest is the dummy variable CH_{it}, which is zero before the firm joins the clearinghouse and one afterward.

As stated earlier, it is important to add controls variables that have been shown in the past to also affect trading costs. In the above equation, α_i and B_{1i} represent the market model parameters for each firm i using ordinary least squares (OLS). Firm-specific explanatory variables such as volume and closing price, VOL_{it} and CLOSE_{it}, are measured as the natural log of the NYSE daily trading volume and closing price for firm *i* on day *t*. Next, STDEV_{it} is defined as the standard deviation of security i's return during the 50 days before entering the clearinghouse and the 50 days after. This variable captures the volatility of security i's return over the entire sample period. SHARE_{it} is calculated as security i's percentage of NYSE volume to Consolidated Volume. I include this variable in the regression to control for the Consolidated only trading the most liquid securities on the NYSE, which captures the competition between these two exchanges. CALL_{it} represents the weekly broker call rate and is included to measure the cost of holding an inventory of stocks. RETURN_{it} is calculated as the capital gains or losses an investor would incur by purchasing a security's stock on day *t-1* and selling it on day *t*. When the dummy variable for Clearinghouse is multiplied by share, $\text{SHARE}_{it} * \text{CH}_{it}$, this reports the impact of competition between the Consolidated and the NYSE. I also include CONS_{it} in my regression, in order to determine the Consolidated's impact on spreads and to analyze which firms were being traded on the Consolidated. MONTH_{it} takes on the value of zero if security i was not being traded during that month and the value of one if it was being traded. For instance, the 50 days before and after Lake Shore & Michigan joins the Clearinghouse are between June and October. Thus, during these specific months, the dummy variable takes on a value of one. The error term is denoted by ε_{it}. Each regression was run as robust in STATA, assuming that the stand errors are type-I heteroskedasticity, which controls for erroneous biases that would skew my results.

Table 3 reports the summary statistics for the calculated spreads. The sample contains 2,983 observations. Across the seven years, the average relative spread was 90 basis points, with a standard deviation of 80 basis points. The relative spread ranged from 6 basis points to 1300 basis points. In comparison, the average absolute spread was \$0.37 with a standard deviation of \$0.30. The average absolute spread ranged from \$0.125 to \$2.00. The mean closing price for a security is $59.36. The average weekly broker call rate is $2.58. The mean return for market makers is $0.005. The mean standard deviation of return for a security is 9.00% over the 100 day sample period. The average volume is 4,205 individual daily shares. The mean share of total volume was 7.00% for securities with NYSE volume.

Table 5 reports the results for the estimation of my basic model, excluding the monthly dummies. I report four specifications that examine the determinants of relative and absolute spreads that include and omit firm specific variables, control variables, and dummy variables. Column (3) of Table 5 includes firm specific variables and control variables, which are the weekly broker call rate, a security's return, and standard deviation. According to the regression in column (3), controlling for all other variables, the clearinghouse dummy decreases the mean relative spread from 90 basis points ($9.00 on a $100 investment) to 85 basis points, which is approximately a 5.28 percent decrease in the spread after the firm entered the NYSE clearinghouse. Additionally, I report that closing price, volume, and share are all negatively related to relative spread. In contrast, the consolidated dummy is positively related to the spread, which may represent an error in my dataset as the variable should have a negative coefficient due to competition decreasing spreads as explained in other papers. All variables and the constant are significant at the 1% level. Overall, this regression accounts for a decrease in the relative spread by approximately 17 percent and 46 percent of the variation in the relative spread can be accounted for by this regression.

Similar results were obtained in column (4), except that the closing price is positively related to the absolute spread. The clearinghouse dummy reports that the mean absolute spread fell from $0.37 to $0.348. After a firm joined the NYSE clearinghouse, its absolute spread decreased by 5.28 percent. However, the regressions in column (3) and (4) report that the

Consolidated dummy's coefficient is positively related to both spreads, which contradicts my hypothesis that the Consolidated dummy would have a negative coefficient. One reason there is a positive relationship between spreads and the Consolidated dummy is that the NYSE clearinghouse was losing market share to the Consolidated as the Consolidated offered competitive pricing by lowering the minimum tick quote. Overall, however, this regression yields the same results as column (4) and reports a 17 percent decline in the absolute spread and 35 percent of the variation in the absolute spread is accounted for by this regression.

Due to a relatively high correlation between closing price and spreads, I recalculated equation (1) by removing this variable from my regressions as seen in Table 6. I also omitted the variable share multiplied by the clearinghouse. There are six specifications presented in Table 6. Interpreting the clearinghouse dummy in column (1), I find that the mean relative spread at 90 basis points will decrease to 40 basis points, which is approximately a 53 percent decline in the spread, once the firm becomes a member of the NYSE clearinghouse. In addition, there is a negative relationship between the natural log of relative spread and the broker's call rate, volume, share, and standard deviation of return. A security's shares, volume, clearinghouse dummy as well as the constant are all significant at the 1% level. The broker call rate is significant at the 5% level, and the standard deviation of return is significant at the 10% level. According to this model, a one percent increase in a security's share will result in a 9.21 percent drop in the relative spread, meaning that the mean relative spread will fall from 90 basis points to 83 basis points. This finding substantiates Brown *et al.*'s paper that asserts that the competition between the two exchanges helps to reduce the spreads. Overall, this regression accounts for 11 percent reduction in relative spreads and explains 49 percent of the variation in the relative spread.

Column (2) yields similar results to column (1), and yet there are a few exceptions. According to this regression, the clearinghouse dummy is positively related to the absolute spread, which contradicts my hypothesis. In absolute terms, the median spreads rise from $0.37 to$ 0.604, which represents a 63 percent increase in the spreads. Clearly there is an error in my results. A possible reason for this may be errors in the data as they were input by hand. Analogous to column (1), however, volume and share are negatively related to the absolute spread, and are significant at the 1% level. According to this model, a one percent increase in share will decrease the spread by approximately 3.94%, meaning that the mean absolute spread will decrease from $0.37 to $0.355. Also, the broker call rate validates the theory that as interest rates rise, spreads will rise and vice versa. In this instance, spreads will diminish by approximately 0.04 percent due to the weekly broker call rate. Overall, this model accounts for 34 percent variation in the absolute spreads.

Column (3) and (4) report the same regression as seen in column (1) and (2), but hold the weekly broker call rate and Consolidated dummy constant. According to column (3), the clearinghouse dummy accounts for 43 percent decline in the mean relative spread from 90 basis points to 50 basis points. Again, this means that once a firm joins the NYSE clearinghouse, its spreads will dramatically narrow. Moreover, the relative spread diminishes by 8.48 percent as a security's share increases. The market volatility, as represented by the standard deviation of returns, declines by approximately 6.14 percent. The overall regression accounts for 10 percent decline in relative spreads and explains 47 percent variation in the relative spread.

Column (4), however, yields a positive coefficient for the clearinghouse dummy as seen in column (2). According to the clearinghouse dummy, the mean absolute spread will increase from $0.37 to $0.63, representing a 72 percent increase in the spreads. Again, there is clearly an error in my dataset that is skewing my results. However, the model reports that both volume and share are negatively related to the absolute spread and are significant at the 5% and 1%, respectively. A one percent increase in share will result in a 3.22 percent decline in the spread. Overall, this model explains 31 percent variation in the absolute spreads.

Column (5) and (6) report the results holding the standard deviation of return constant. In these two models, the clearinghouse dummy is negatively related to both the relative and the absolute spread. According to Table 4.2, there exists a positive correlation of 30 percent between the natural log of absolute spread and the standard deviation of returns. This might explain why my regressions in column (2) and (4) were yielding a positive relationship between the absolute spread and the clearinghouse dummy even though the clearinghouse dummy and the standard deviation of return have a positive correlation of 1 percent.

Column (5) shows that there is a negative relationship between the relative spread and the clearinghouse dummy, broker call rates, volume, and share. According to this model, the clearinghouse dummy accounts for 12.19 percent drop in the spread as the mean relative spread diminishes from 90 basis points to 79 basis points ($7.90 on $100 investment). Moreover, as the broker call rate declines the spread will also decline by 0.07 percent. Similarly, the spread will diminish by 0.09 percent due to share. The broker call rates, volume, and clearinghouse dummy are significant at the 1% level and share is significant at the 5% level. Overall, this regression represents 2.54 percent decline in the relative spread and accounts for 15 percent of the variation seen in the relative spread.

Table 7, which has four specifications, presents my results, including the effect of the monthly dummy variables on spreads. Column (1) reports that the natural log of relative spread is a function of the clearinghouse dummy, closing price, January, February, March, April, May, June, July, August and October. According to this model, once a firm joins the NYSE clearinghouse, its relative spread declines by approximately 5.82 percent. This means that the mean relative spread was reduced from 90 basis points to 84 basis points ($8.40 on $100 investment) after joining the NYSE clearinghouse. All variables are significant at the 1% level except for January, March, and October, which are significant at the 5%, 5% and 10% levels, respectively. Because the majority of firms entered the NYSE clearinghouse during those months, the monthly dummy variables are all negatively related to the spread, with the exception of October. Once the firm joined the clearinghouse, its spread decreased, which happened during those months. Overall, the regression represents an 8 percent decline in the relative spread and explains 39 percent variation in the relative spread.

In accordance, column (2) yields similar results to column (1) except that the closing price is positively related to the absolute spread. According to the model, once a firm enters the NYSE clearinghouse, its absolute spread will decrease by approximately 6 percent. In absolute terms, the median spread will fall from $0.37 to $0.348. Also, one can interpret the reason for why the monthly dummy variables are negative is due to the fact that most firms joined the NYSE clearinghouse during those months, which results in their spreads declining. The overall regression accounts for an 8 percent decrease in the absolute spread and explains 26 percent of the variation as displayed in the absolute spread.

Both Column (3) and (4) omit the share multiplied by the clearinghouse dummy, September and November. In column (3) and (4), the clearinghouse dummy again accounts for an approximately 6 percent narrowing in both the relative and the absolute spreads from 90 basis points to 84 basis points and from $0.37 to $0.348, respectively. Furthermore, both regressions, in general, account for an approximately 8 percent decline in both the relative and the absolute spreads as well as explain 39 and 27 percent of the variation in both the relative and absolute spreads, respectively.

My results validate the inventory holding model that states that once a security joins a clearinghouse, its bid-ask spread declines, reducing transaction costs between market makers. This is verified by the fact the clearinghouse dummy's coefficient is negative and statistically significant implying that once a firm becomes a member of the NYSE clearinghouse, its spreads narrow. Furthermore, the closing price, volume, and broker call rate all decline as proven by previous literature. My results demonstrate that market makers expect to be compensated for their risk of holding a security as reflected in the broker call rate variable.

VI. Conclusion

This paper investigates the effect of transaction costs on 30 firms' bid-ask spreads between 1893 to 1900. I use a multiple variable linear regression to test the significance between different variables and spreads. My analysis proves that the clearinghouse dummy is statistically significant in explaining a reduction in spreads. Furthermore, my analysis supports previous literature that finds that the closing price, volume, broker call rate and share are all significant in explaining both the relative and the absolute spreads. My findings substantiate the inventory holding premium theory and conclude that the introduction of a clearinghouse narrows spreads.

Previous literature and studies have theorized about the determinants of bid-ask spreads, but were unable to provide empirical support about how a clearinghouse affects spreads. There remains little empirical evidence to support the hypothesis that a clearinghouse reduced a security's spread. This study fills the gap by considering daily stock data during the time of the introduction of the NYSE clearinghouse.

This paper also opens several other areas for future study. For instance, this paper can be viewed as a historical experiment in which lessons can be drawn for introducing a clearinghouse for the derivatives market, in particular the CDS market. If the historical data for all securities that joined the NYSE clearinghouse were acquired, then it would be possible to expand this paper by examining the effect of the introduction of the NYSE clearinghouse over more years, allowing for further insight into longer trends. Also, one could examine the affect on spreads by dividing the firms into various sectors, such as seeing whether railroad firm's experienced more of a decrease in their spreads than other industry firms. Furthermore, this data could also incorporate the years after the Consolidated exchange was closed to see if spreads changed. This would enable researchers to find which firms benefited more than other firms from joining the NYSE Clearinghouse. Nevertheless, I find that the NYSE Clearinghouse was extremely beneficial to its members as transaction costs fell, increasing investor's returns and ultimately, narrowing spreads.

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Appendix

Table 1 – Dates when firms joined the New York Stock Exchange Clearinghouse

Table 1 displays the particular day on which firms entered the Clearinghouse and became members. These dates were collected by Emily Case, who gathered the data from the NYSE's historical archives. It is important to note that not all firms that became members of the clearinghouse are reported in this table. That being said, however, these are the dates used in this paper.

Firm	Entering Date
Chicago, Milwaukee & St. Paul	17-May 1892
Louisville & Nashville	17-May 1892
Northern Pacific preferred	17-May 1892
Philadelphia & Reading	17-May 1892
Atchison	24-May 1892
Chicago, Burlington & Quincy	24-May 1892
Rock Island	24-May 1892
Union Pacific	24-May 1892
Chicago Gas	4-June 1892
Missouri Pacific	4-June 1892
New York, Lake Erie & Western	4-June 1892
New York & New England	4-June 1892
Delaware, Lackawanna & Western	15-June 1892
American Sugar common	15-June 1892
Western Union	15-June 1892
Distilling & Cattle Feeding	21-September 1892
National Lead common	27-December 1892
Manhattan	25-January 1893
National Cordage common	23-February 1893
American Cotton Oil common	23-February 1893
General Electric	22-March 1893
Chicago & Northwestern	26-July 1893
Lake Shore & Michigan	16-August 1893
New York Central	16-August 1893
New Jersey Central	15-November 1894
Delaware & Hudson	15-November 1894
Southern Railroad common	3-April 1895
Southern Railroad preferred	3-April 1895
American Tobacco	1-May 1895
United States Leather preferred	1-May 1895
Missouri, Kansas & Texas	1-May 1895
Chesapeake & Ohio	29-May 1895
Texas Pacific	29-May 1895

Wabash preferred	29-May 1895
Ontario & Western	29-May 1895
United States Rubber common	26-June 1895
New York, Susquehanna & Western preferred	26-June 1895
Tennessee Coal & Iron	26-June 1895
Wheeling & Lake Erie common	21-August 1895
Pacific Mail	20-November 1895
Reading First preferred	26-July 1897
Reading Second preferred	26-July 1897
Metropolitan Street Railway	12-January 1898
Brooklyn Rapid Transit	12-January 1898
Consolidated Gas	4-February 1898
Central Pacific	17-January 1899
Southern Pacific	17-January 1899
American Steel common	11-September 1899
Norfolk Western preferred	11-September 1899
Third Avenue	26-February-1900

Table 2 – List of Variables

Variable	Definition
ba_rel	The relative spread
ln_barel	Natural logarithm of the relative spread
ba_abs	The absolute spread
ln_baabs	Natural logarithm of the absolute spread
ln_last	Natural logarithm of security *i*'s closing price
call	Weekly broker call rate
return	Return on security *i*
stdevofreturn	Standard deviation of security *i*'s return
ln_vol	Natural logarithm of security *i*'s NYSE clearinghouse volume
share	Market share
ch	Clearinghouse dummy
cons	Consolidated dummy
sharech	Market share multiplied by Clearinghouse dummy
Month	Monthly dummy

Table 3 – Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
ba_rel	2983	0.009	0.008	0.0006	0.13
ln_barel	2983	-5.04	0.74	-7.34	-2.02
ba_abs	2983	0.37	0.30	0.125	2
ln_baabs	2983	-1.26	0.68	-2.08	0.69
ln_last	2983	3.79	0.78	1.98	5.27
call	2983	2.58	2.18	1	25
return	2982	0.005	0.12	-0.93	4.28
stdevofreturn	30	0.09	0.08	0.02	0.43
ln_vol	2983	7.46	1.45	0	11.19
share	2983	0.07	0.45	0	22
ch	2983	0.5	0.5	0	1
cons	2983	0.91	0.29	0	1
share	2983	0.07	0.46	0	22
sharech	2983	0.04	0.42	0	22

Table 4.1 – Correlation Matrix using ln_barel as dependent variable

	ln_barel*	ln_last	call	return	stdev	ln_vol	share	ch	cons	share*ch
ln_barel*	1									
ln_last	-0.59	1								
call	-0.20	0.32	1							
return	-0.05	0.05	0.02	1						
stdev	-0.03	0.30	0.04	0.84	1					
ln_vol	-0.32	0.01	0.05	0.01	-0.10	1				
share	-0.04	0.01	0.01	0.00	-0.27	-0.06	1			
ch	-0.09	0.06	0.06	-0.03	0.01	0.04	0.04	1		
cons	-0.05	0.07	0.09	-0.02	-0.05	0.10	0.04	0.30	1	
share*ch	-0.02	0.00	0.02	0.00	0.01	-0.06	0.94	0.10	0.03	1

Table 4.2 – Correlation Matrix using ln_baabs as dependent variable

	ln_baabs*	ln_last	call	return	stdev	ln_vol	share	ch	cons	share*ch
ln_baabs*	1									
ln_last	0.50	1								
call	0.15	0.32	1							
return	0.01	0.05	0.02	1						
stdev	0.30	0.30	0.04	0.84	1					
ln_vol	-0.33	0.01	0.05	0.01	-0.10	1				
share	-0.02	0.01	0.01	0.00	-0.27	-0.06	1			
ch	-0.02	0.06	0.06	-0.03	0.01	0.04	0.04	1		
cons	0.03	0.07	0.09	-0.02	-0.05	0.10	0.04	0.30	1	
share*ch	-0.02	0.00	0.02	0.00	0.01	-0.06	0.94	0.10	0.03	1

Table 5 – The effect of firm specific, control and dummy variables

VARIABLES	(1) Natural Log of Relative Spread	(2) Natural Log of Absolute Spread	(3) Natural Log of Relative Spread	(4) Natural Log of Absolute Spread
ln_last	-0.56**	0.45**	-0.57***	0.43***
	(0.18)	(0.17)	(0.01)	(0.01)
callloan	-0.00	-0.00		
	(0.01)	(0.01)		
return	-0.24	-0.23		
	(0.23)	(0.23)		
stdevofreturn	2.53	2.46		
	(3.06)	(3.03)		
ln_vol	-0.27**	-0.27**	-0.16***	-0.16***
	(0.10)	(0.10)	(0.01)	(0.01)
share	-5.77**	-5.79**	-0.08***	-0.08***
	(2.21)	(2.21)	(0.02)	(0.02)
ch_dummy	-0.17	-0.18	-0.06***	-0.06**
	(0.31)	(0.31)	(0.02)	(0.02)
cons_dummy	0.41	0.40	0.09***	0.09**
	(0.30)	(0.30)	(0.04)	(0.04)
share_ch			0.08	0.08
			(0.10)	(0.10)
Constant	-1.25	-1.26	-1.76***	-1.76***
	(0.99)	(0.98)	(0.07)	(0.07)
Observations	29	29	2983	2983
R-squared	0.74	0.54	0.47	0.36
Adj. R-Squared	0.64	0.36	0.46	0.35

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Table 6 – The effect of firm specific, control and dummy variables, excluding closing price

VARIABLES	(1) Natural Log of Relative Spread	(2) Natural Log of Absolute Spread	(3) Natural Log of Relative Spread	(4) Natural Log of Absolute Spread	(5) Natural Log of Relative Spread	(6) Natural Log of Absolute Spread
callloan	-0.04**	0.02			-0.07***	0.04***
	(0.02)	(0.01)			(0.01)	(0.01)
ln_vol	-0.35***	-0.29***	-0.31***	-0.23**	-0.16***	-0.16***
	(0.12)	(0.09)	(0.11)	(0.09)	(0.01)	(0.01)
share	-9.21***	-3.94***	-8.48***	-3.22***	-0.09**	-0.07***
	(1.48)	(1.17)	(1.14)	(1.09)	(0.04)	(0.02)
ch_dummy	-0.76***	0.49***	-0.56***	0.54***	-0.13***	-0.01
	(0.23)	(0.17)	(0.18)	(0.14)	(0.03)	(0.02)
cons_dummy	0.49	0.44			0.06	0.12***
	(0.38)	(0.33)			(0.04)	(0.04)
stdevofreturn	-2.97*	1.59	-2.79*	1.67		
	(1.72)	(1.30)	(1.41)	(1.17)		
Constant	-2.23***	0.38	-2.30***	0.37	-3.67***	-0.30***
	(0.76)	(0.65)	(0.79)	(0.70)	(0.07)	(0.07)
Observations	30	30	30	30	2983	2983
R-squared	0.59	0.48	0.54	0.40	0.15	0.13
Adj. R-Squared	0.48	0.34	0.47	0.31	0.15	0.13

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Table 7 – The effect of monthly variables on spreads

VARIABLES	(1) Natural Log of Relative Spread	(2) Natural Log of Absolute Spread	(3) Natural Log of Relative Spread	(4) Natural Log of Absolute Spread
ln_last	-0.61***	0.39***	-0.61***	0.39***
	(0.02)	(0.02)	(0.02)	(0.02)
ch_dummy	-0.06***	-0.06**	-0.06**	-0.06**
	(0.02)	(0.02)	(0.02)	(0.02)
share_ch	0.06	0.06		
	(0.11)	(0.11)		
share	-0.09	-0.09	-0.04**	-0.04**
	(0.10)	(0.10)	(0.02)	(0.02)
jan	-0.14**	-0.14**	-0.11**	-0.11**
	(0.07)	(0.07)	(0.06)	(0.06)
feb	-0.28***	-0.28***	-0.25***	-0.25***
	(0.07)	(0.07)	(0.05)	(0.05)
mar	-0.12**	-0.12*	-0.09**	-0.09*
	(0.06)	(0.06)	(0.05)	(0.05)
apr	-0.22***	-0.22***	-0.19***	-0.19***
	(0.06)	(0.06)	(0.05)	(0.05)
may	-0.28***	-0.28***	-0.25***	-0.25***
	(0.06)	(0.06)	(0.04)	(0.04)
jun	-0.29***	-0.29***	-0.26***	-0.26***
	(0.06)	(0.06)	(0.04)	(0.04)
july	-0.18***	-0.18***	-0.15***	-0.15***
	(0.06)	(0.06)	(0.04)	(0.04)
august	-0.17***	-0.17***	-0.14***	-0.14***
	(0.06)	(0.06)	(0.05)	(0.05)
sep	-0.04	-0.04		
	(0.07)	(0.07)		
oct	0.12*	0.12*	0.15***	0.15***
	(0.07)	(0.07)	(0.05)	(0.05)
nov				
dec	-0.05	-0.05		
	(0.07)	(0.07)		
Constant	-2.54***	-2.54***	-2.57***	-2.57***
	(0.08)	(0.08)	(0.07)	(0.07)
Observations	2983	2983	2983	2983
R-squared	0.39	0.27	0.39	0.27
Adj. R-Squared	0.39	0.26	0.39	0.27

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10