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Large Investors, Price Manipulation, and Limits to Arbitrage: An Anatomy of Market Corners *

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Abstract. Corners were prevalent in the nineteenth and early twentieth century. We first develop a rational expectations model of corners and show that they can arise as the result of rational behavior. Then, using a novel hand-collected data set, we investigate price and trading behavior around several well-known stock market and commodity corners which occurred between 1863 and 1980. We find strong evidence that large investors and corporate insiders possess market power that allows them to manipulate prices. Manipulation leading to a market corner tends to increase market volatility and has an adverse price impact on other assets. We also find that the presence of large investors makes it risky for would-be short sellers to trade against the mispricing. Therefore, regulators and exchanges need to be concerned about ensuring that corners do not take place since they are accompanied by severe price distortions.

1. Introduction

Although stock markets are far better regulated today than in the nineteenth century, market manipulations by large investors and insiders still occur around the world. Most recently, in August 2004, Citigroup placed sell orders for no fewer than 200 different types of Eurozone government bonds worth almost €12.9 billion in the space of 18 seconds. They bought back at lower prices the same morning and earned profits of €18.2 million.[1] This action reduced the subsequent liquidity of the market significantly. In May 1991, a bond trader at Salomon Brothers was discovered attempting to corner the market in two-year U.S. Treasury notes.[2] During the 1990s bull market, numerous price manipulation schemes for penny stocks

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[1] See the Financial Times, August 23, 2006, "The day Dr Evil wounded a financial giant".

[2] See Jegadeesh (1993) and Jordan and Jordan (1996) for detailed studies on the Treasury auction bids and the Salomon price squeeze.

were discovered by the SEC.[3] Manipulation knows no international borders. In 2002, China's worst stock-market crime was a scheme to manipulate the share price of a firm called China Venture Capital. Seven people, including two of the firm's former executives, were accused of using $700 million and 1,500 brokerage accounts nationwide to manipulate the company share price. Krugman (1996) also reported a price manipulation in the copper market by a rogue trader at the Japanese trading firm Sumitomo. More recently British Petroleum has been investigated by the SEC for the possibility of cornering the U.S. propane market in early 2004.[4]

There is a growing theoretical literature on market manipulation. Hart (1977), Hart and Kreps (1986), Vila (1987, 1989), Allen and Gale (1992), Allen and Gorton (1992), Benabou and Laroque (1992), and Jarrow (1992, 1994) were among the first to study market manipulation. Cherian and Jarrow (1995) survey this early literature. Subsequent contributions include Bagnoli and Lipman (1996), Chakraborty and Yilmaz (2004a, b), and Goldstein and Guembel (2003). Kumar and Seppi (1992) discuss the possibility of futures manipulation with cash settlement. Pirrong (1993) shows how squeezes hinder price discovery and create deadweight losses. Vitale (2000) considers manipulation in foreign exchange markets. Van Bommel (2003) shows the role of rumors in facilitating price manipulation.

In contrast, the empirical literature is quite limited. Although the wide-spread manipulation through stock pools before the Crash of 1929 is vividly documented in Galbraith (1972), Mahoney (1999) and Jiang et al. (2005) find little evidence of price manipulation for the stock pools. However, there are a few recent studies that have found evidence of market manipulation. Aggarwal and Wu (2006) present a theory and some empirical evidence on stock price manipulation in the United States. Extending the framework of Allen and Gale (1992), they show that more information seekers imply greater competition for shares in a market with manipulators, making it easier for a manipulator to enter the market and potentially worsen market efficiency. Using a unique dataset from SEC actions in cases of stock manipulation, they find that more illiquid stocks are more likely to be manipulated and manipulation increases stock volatility. Khwaja and Mian (2005) discover evidence of broker price manipulation by using a unique daily trade level data set from the main stock market in Pakistan. They find that brokers earn at least 8% higher returns on their own trades. While neither market timing nor liquidity provision offer sufficient explanations for this result, they find compelling evidence for a specific trade-based "pump-and-dump" price manipulation scheme. Merrick

[3] For example, the SEC intervened in 1996 when the share price of Comparator Systems Corporation (a finger print identification company with net assets of less than $2 million) soared from 3 cents to $1.03, valuing the company at a market capitalization of over a billion dollars. An astonishing 180 million Comparator shares were traded on the Nasdaq Exchange on May 6, 1996. See also Aggarwal and Wu (2006).

[4] See the Wall Street Journal of June 29, 2006, "U.S. Accuses BP of manipulating Price of Propane".

et al. (2005) provide empirical evidence on learning in the market place and on the strategic behavior of market participants by studying an attempted delivery squeeze in the March 1998 long-term UK government bond futures contract traded on the London International Financial Futures and Options Exchange (LIFFE). Felixon and Pelli (1999) test for closing price manipulation in the Finnish stock market and find evidence of it. They find that block trades and spread trades explained a part, but not all of the observed manipulation. Mei, Wu and Zhou (2004) construct a theoretical example in which smart money strategically takes advantage of investors' behavioral biases and manipulates the price process to make a profit. As an empirical test, the paper presents some empirical evidence from the U.S. SEC prosecution of "pump-and-dump" manipulation cases. The findings from these cases are consistent with their model.

This paper fills a gap in the manipulation literature by studying corners. We first develop a rational expectations model of the phenomenon similar to that in Grossman and Stiglitz (1980). There are two assets; one is safe and one is risky with a random payoff and an unobservable random aggregate per capita supply. There are three groups: arbitrageurs, the uninformed, and a manipulator. The arbitrageurs receive a signal that indicates whether the payoff on the risky asset will be high or low. We first consider equilibrium when there is no manipulator present. There exists a pooling equilibrium where the arbitrageurs go long in the risky asset when they receive a good signal and short when they receive a bad signal. The price of the risky asset is such that the uninformed cannot distinguish between situations where there is a good signal and the supply is large and situations where there is bad signal and supply is low. This allows the market to clear at the same price in both situations. We then introduce the manipulator. He can with some probability buy up the floating supply and this allows him to corner the market when the arbitrageurs are short. They are forced to settle at a high price when the corner succeeds. This possibility means that they will only short the stock when the potential profits offset the risk of being cornered. However, for prices close to their expectation of the stock's payoff it is not worthwhile for them to take a short position. As a result the market is less efficient than when corners are not possible. Nevertheless it is rational for all agents to participate.

We then go on to provide a clinical study of market corners from the robber-baron era to the Great Depression of the 1930s to the 1980s.[5] This involves several contributions: first, we have put together by hand a novel data set of price and trading volume based on historical newspapers from the *New York Times* and the *Wall Street Journal* from 1863–1980. This allows us to provide the first systematic account of some well-known market corners in US financial history. Second, we present some unique evidence on the price and volume patterns of successful corners. We show that market corners tend to increase market volatility and have an adverse price impact on other assets. Third, we demonstrate that the presence of

[5] Jarrow (1992) provides a collection of early references on attempted corners in individual common stocks.

large investors makes it extremely risky for short sellers to trade against mispricing in the stock market. This creates severe limits to arbitrage in the stock market that impede market efficiency. Therefore, regulators and exchanges need to ensure that corners do not take place since they are accompanied by severe price distortions.

The structure of the paper is as follows. Section 2 presents a simple model of market corners. Section 3 considers the data and institutional background. The empirical results are presented in Section 4. Section 5 contains concluding remarks.

2. Theoretical Analysis

2.1. THE MODEL

The model of corners developed in this section is a variant of Grossman and Stiglitz's (1980) rational expectations model. The model shows how corners can occur when everybody is behaving rationally. As is standard in rational expectations models, all agents know the structure and parameters of the model.

Assets

There are two assets, which are traded in competitive markets at date 0. The first is a storage technology and yields 1 at date 1 for every 1 invested at date 0. The second is risky. It is traded at price P at date 0 and has a random payoff v at date 1 that is observable where

$$v = \theta + \varepsilon. \tag{1}$$

θ and ε are independent random variables that cannot be publicly observed. As we will see, some traders can privately observe θ. The distribution of θ is

$$\begin{aligned} \theta_B &= E\theta - \eta \quad \text{with probability 0.5,} \\ \theta_G &= E\theta + \eta \quad \text{with probability 0.5.} \end{aligned} \tag{2}$$

The mean of the distribution is $E\theta$ and the variance is η^2. θ_B corresponds to the bad state and θ_G to the good one. ε is normally distributed with mean 0 and variance σ_ε^2. Since θ and ε are independently distributed we have

$$\sigma_v^2 = \eta^2 + \sigma_\varepsilon^2. \tag{3}$$

The aggregate per capita supply of the risky asset at date 0, x, that is available for trading is stochastic. This is the "free float". It is uniformly distributed between 0 and x_H, is independent of θ and ε, and cannot be observed.

Agents

There are three types of agent, the uninformed, the arbitrageurs, and the manipulator.

The uninformed constitute a proportion λ of the population, and they behave competitively. They have a constant absolute risk aversion (CARA) utility function,

$$U(W_1) = -exp[-\gamma W_1], \tag{4}$$

where W_1 is wealth at date 1. Each uninformed person is endowed with wealth W_0 at date 0 and purchases S_U of the safe asset and X_U of the risky asset so their budget constraints at dates 0 and 1 are

$$W_0 = S_U + PX_U, \tag{5}$$

$$W_1 = S_U + vX_U. \tag{6}$$

The second type of agent is the arbitrageurs. They are risk neutral, behave competitively, and are a proportion $1 - \lambda$ of the population. The amount they can trade is constrained by their wealth. The largest long position they can each take is $+X_A^*$ and the largest short position is $-X_A^*$. This is the restriction that limits arbitrage.

The third type of agent is the manipulator. He is also risk neutral. He is a negligible proportion of the population but has significant wealth. He behaves strategically rather than competitively. His demand for the risky asset is X_M. For the first part of the analysis we exclude the manipulator and consider only the uninformed and the arbitrageurs.

2.2. EQUILIBRIUM WITH EVERYBODY UNINFORMED

We start by considering the case where neither the uninformed nor the arbitrageurs can observe θ. This will act as a benchmark for the case where only the arbitrageurs can observe θ. The sequence of events in this case is as follows. At date 0, the uninformed and arbitrageurs submit their demand functions and the market for the risky asset clears at price P. At date 1 the risky asset pays off v.

It can be shown using the moment generating function for the normal distribution that the demand of the uninformed X_U is given implicitly by

$$(E\theta - P - \gamma X_U \sigma_\varepsilon^2)(1 + e^{2\gamma\eta X_u}) + \eta(1 - e^{2\gamma\eta X_u}) = 0. \tag{7}$$

If the arbitrageurs are uninformed their demand will be as follows

$$\begin{aligned} X_A &= -X_A^* \text{ for } P > E\theta, \\ &= -X_A^* \text{ to } + X_A^* \text{ for } P = E\theta, \\ &= +X_A^* \text{ for } P < E\theta. \end{aligned} \tag{8}$$

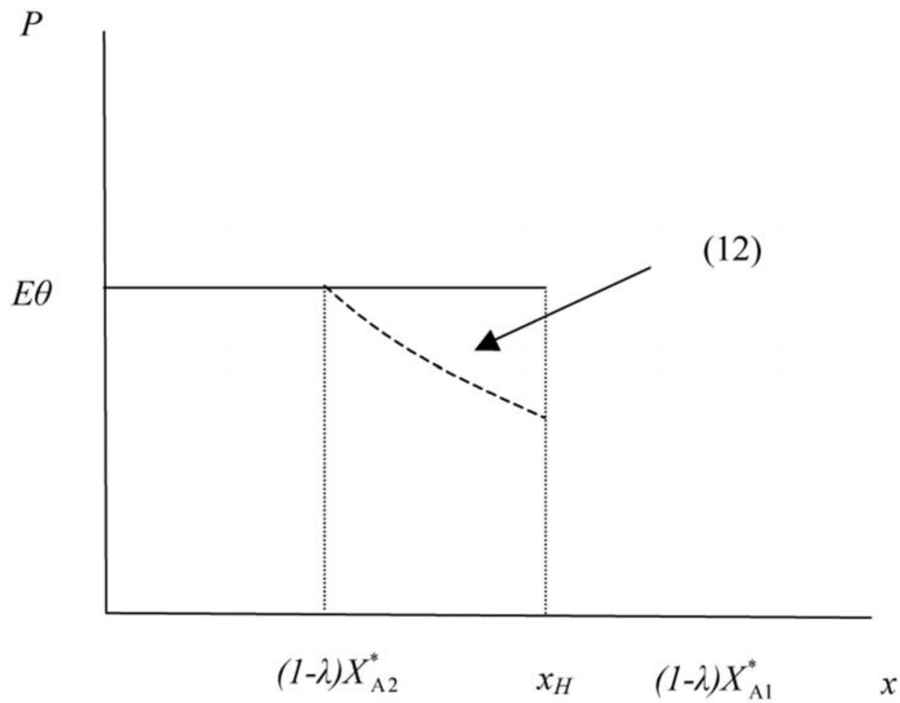


Figure 1. Possible equilibria when everybody is uninformed.

Market clearing requires

$$\lambda X_U + (1-\lambda) X_A = x. \tag{9}$$

The form of the equilibrium depends on how large a position the arbitrageurs can take relative to the aggregate per capita supply. Suppose initially that $X_A^* = X_{A1}^*$ where

$$(1-\lambda) X_{A1}^* \geq x_H. \tag{10}$$

In this case the equilibrium has the form shown by the solid line in Figure 1. The arbitrageurs bid the price to $P = E\theta$ and the uninformed hold nothing at this price since they are risk averse so $X_A = x/(1-\lambda) \leq X_{A1}^*$.

In the case $X_A^* = X_{A2}^*$ where

$$(1-\lambda) X_{A2}^* < x_H, \tag{11}$$

the arbitrageurs do not have enough wealth to hold the entire supply when x is high. In this case the price must fall so that the uninformed will be willing to hold the asset. Since $P < E\theta$ the arbitrageurs will have $X_A = X_{A2}^*$. Using this with (7) in (9) and rearranging gives

$$P = E\theta - \gamma X_U \sigma_\varepsilon^2 + \eta \left(\frac{1 - e^{2\gamma\eta X_U}}{1 + e^{2\gamma\eta X_U}} \right) \text{ where } X_U = \frac{x - (1-\gamma) X_{A2}^*}{\lambda}. \tag{12}$$

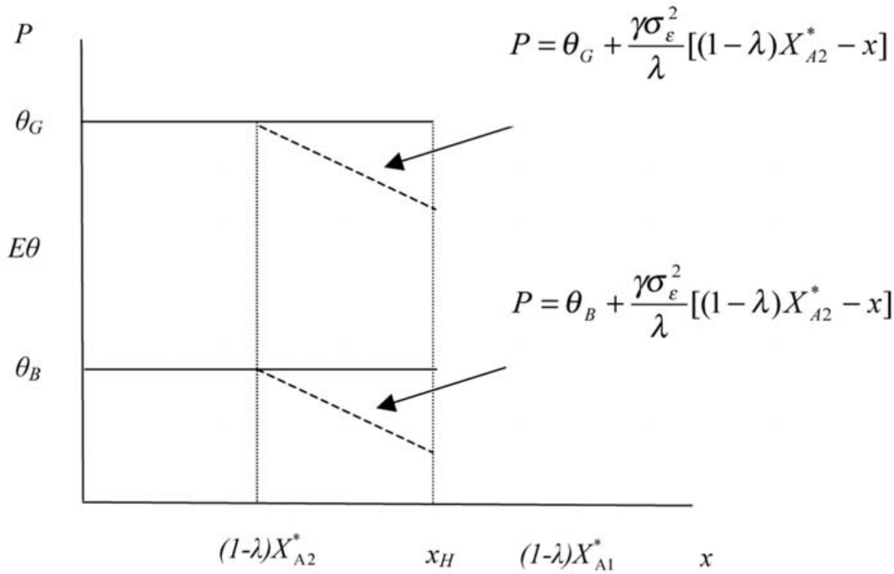


Figure 2. Possible fully revealing equilibria.

The equilibrium is shown in Figure 1. For $x \leq (1-\lambda)X^*_{A2}$, only the arbitrageurs hold the asset and then for higher x the relationship between P and x is given by (12) as shown by the dotted line.

2.3. EQUILIBRIUM WITH JUST ARBITRAGEURS INFORMED

Suppose next that only the arbitrageurs observe θ at date 0 before they trade. If they observe $\theta_G(\theta_B)$, we say that they receive good (bad) news. There are again a number of forms the equilibrium can take. Suppose (10) is satisfied. Similarly to Figure 1, the arbitrageurs bid the price to reflect the information they receive and hold all of the assets. The equilibrium price is fully revealing as shown in Figure 2 by the solid lines. When good news is observed the price is bid to θ_G and the uninformed know that v is normally distributed with mean θ and variance σ_ε^2 When bad news is received the price is bid to θ_B and the uninformed again know v is normally distributed but now with mean θ_B.

When (11) is satisfied then the uninformed must again hold some of the asset. One possibility is that prices are fully revealing. Figure 2 shows this type of equilibrium. When the arbitrageurs observe the good signal, they hold all of the risky assets for $x \leq (1-\lambda)X^*_{A2}$ at $P=\theta_G$. For $x > (1-\lambda)X^*_{A2}$, the uninformed hold the remainder of the risky assets. Since they are able to deduce the arbitrageurs' information from the price we have using the fact that v is $N(\theta_G, \sigma_\varepsilon^2)$ and the moment generating function for the normal distribution,

$$X_U = \frac{\theta_G - P}{\gamma\sigma_\varepsilon^2}. \tag{13}$$

Using this and $X_A = X^*_{A2}$ in the market-clearing condition (9), we obtain similarly to (12) that the demand curve is given by

$$P = \theta_G + \frac{\gamma\sigma_\varepsilon^2}{\lambda}[(1-\lambda)X^*_{A2} - x]. \tag{14}$$

When bad news is received the analysis is the same except that θ_G is replaced by θ_B. The equilibrium in Figure 2 is special in that it arises because of the discreteness of the signals received by the arbitrageurs. If θ_G and θ_B are close together and the uninformed hold the asset, then prices can not fully reveal the information of the arbitrageurs and a partial pooling equilibrium will exist.

An example of such a partial pooling equilibrium is shown in Figure 3. For the range of prices $P_1 > P > P_2$ marked "Pooling", the uninformed cannot distinguish between good news and a high value of x and bad news and a low value of x. Since good news and bad news are equally likely and x is uniformly distributed, no information is contained in the price. The demand of the uninformed is given by (7). If only they were to hold the risky asset, market clearing would require

$$\lambda X_U = x, \tag{15}$$

so using this in (7),

$$P = E\theta - \gamma X_U\sigma_\varepsilon^2 + \eta\left(\frac{1-e^{2\gamma\eta X_U}}{1+e^{2\gamma\eta X_U}}\right) \text{ where } X_U = \frac{x}{\lambda}. \tag{16}$$

This demand curve is shown by the dotted line through $E\theta$ marked "Uninformed" in Figure 3. In fact the arbitrageurs are also in the market. If they receive good news about the stock (observe θ_G) then they go long X^*_A in the risky asset. Using this, (7), and the market clearing condition (9), gives

$$P = E\theta - \gamma X_U\sigma_\varepsilon^2 + \eta\left(\frac{1-e^{2\gamma\eta X_U}}{1+e^{2\gamma\eta X_U}}\right) \text{ where } X_U = \frac{x-(1-\lambda)X^*_A}{\lambda}. \tag{17}$$

This is shown by the line marked "Good News" in Figure 3. If the arbitrageurs get bad news about the stock (observe θ_B) then they go short $-X^*_A$ in the risky asset and in this case

$$P = E\theta - \gamma X_U\sigma_\varepsilon^2 + \eta\left(\frac{1-e^{2\gamma\eta X_U}}{1+e^{2\gamma\eta X_U}}\right) \text{ where } X_U = \frac{x+(1-\lambda)X^*_A}{\lambda}. \tag{18}$$

This is shown by the line marked "Bad News" in Figure 3.

While there is pooling for the intermediate values of x, there is not pooling towards the endpoints. When $0 < x < x_1$ and the arbitrageurs receive good news, there are no states with bad news with which to pool. What happens is that the state is revealed and the uninformed demand curve is given by (12). This part of

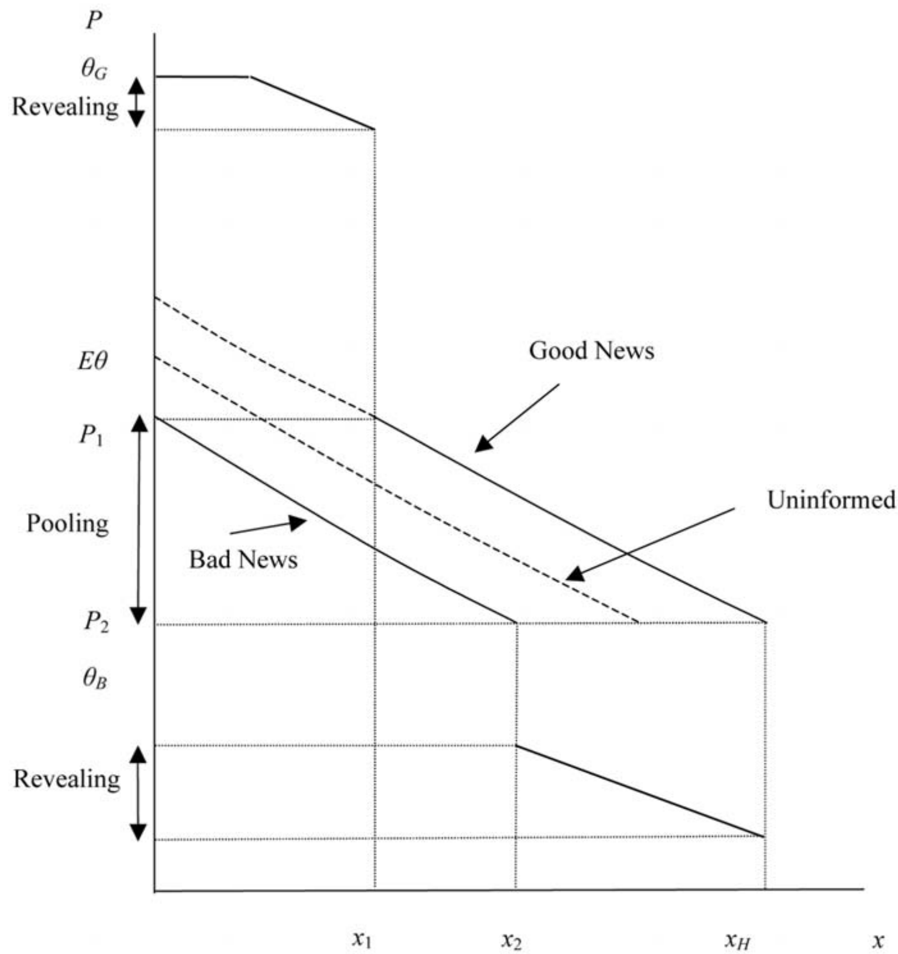


Figure 3. An equilibrium with pooling.

the equilibrium is similar to Figure 2. Similarly, for $x_2 < x < x_H$ when there is bad news there is again revelation as shown in Figure 3.

2.4. CORNERS

In order for corners to occur, there must be short sales in equilibrium. Hence the equilibria shown in Figures 1 and 2 are not susceptible to corners. However, the equilibrium in Figure 3 does have short sales and there is potential for a manipulator to corner the market. We shall therefore focus on this case.

It is assumed that the manipulator has the same information as the arbitrageurs and thus knows whether they have gone long or short. In the latter case the short sellers will need to cover their positions at date 1. In order to do this they must be able to buy up the shares. We assume that with probability π the manipulator will have the spare resources to attempt to corner the market. The manipulator buys up X_M shares between dates 0 and 1. At date 0 the value of X_M is perceived to be random.

For simplicity, it is assumed that the price at which the manipulator buys from the uninformed is the price P_M that gives them a certainty equivalent amount equivalent to the expected utility they would obtain if they kept holding it until it paid off. Notice that the manipulator will find this worthwhile to do whether there is good news or bad news. If there is good news he wants to have the shares because the payoff is high. When there is bad news he wishes to corner the market. Hence the uninformed cannot deduce anything about whether there was good news or bad news from the purchase of the manipulator. We also assume that the uninformed do not monitor the market continuously and so would not be able to sell their holdings to the arbitrageurs if they were to keep the risky asset and there was a corner. Thus it is optimal for the uninformed to sell to the manipulator.

To see how the value of P_M is determined, note that for an uninformed person the expected utility of holding the portfolio (S_U, X_U) is

$$EU(W_1) = -\frac{1}{2}\exp\left[-\gamma\left(S_U + X_U E\theta - \frac{\gamma}{2}\sigma_\varepsilon^2 X_U^2\right)\right] \times (\exp[\gamma X_U \eta] + \exp[-\gamma X_U \eta]). \tag{19}$$

In order to find P_M this level of utility must be equated to that obtained from selling X_U at this price so

$$-\frac{1}{2}\exp\left[-\gamma\left(S_U + X_U E\theta - \frac{\gamma}{2}\sigma_\varepsilon^2 X_U^2\right)\right](\exp[\gamma X_U \eta] + \exp[-\gamma X_U \eta]) = -\exp[-\gamma(S_U + P_M X_U)]. \tag{20}$$

Clearly there are many other assumptions that could be made about the purchase of shares by the manipulator from the uninformed. If the uninformed realize there is a possibility of a corner, they may require a higher payment. Such alternatives could also be modeled. The one chosen is particularly tractable as it does not affect the initial decisions of the uninformed.

At date 1, after v becomes known, some new floating supply of the risky asset, x_n, that is not offered to the manipulator becomes available to the shorts. For example, in a number of corners considered below new shares were issued or shares were obtained by converting bonds. Since the supply becomes available after the payoff v is known, the new supply does not affect the price of the stock. At date 0, the supply x_n is perceived to be random.

A corner fails when the shorts are able to find shares to cover their positions. A corner will fail when

$$X_U + x_n - X_M > (1-\lambda)X_A^*. \tag{21}$$

It can be seen from (21) that there are two factors that can cause a failure to occur. The first is if the manipulator is unable to buy up all the shares of the uninformed that are part of the existing floating supply from date 0, X_U. The second is if a sufficiently large floating supply x_n becomes available to the shorts at date 1. Note that the volume implications of these two possibilities are different. In the case where the corner fails because it is not possible to buy up the existing supply the volume traded with successful corners will be higher than the volume traded with unsuccessful corners. On the other hand, when the failure is due to new supply becoming available the volume will be higher for unsuccessful corners.

The distributions of the random variables X_M and x_n are such that (21) is satisfied and the corner fails with probability φ. The remaining $(1 - \varphi)$ of the time the manipulator succeeds in cornering the market. In this case the manipulator can force the shorts to settle. The price at which the settlement will take place is assumed to be $P_C > \theta_G$.

We next turn to demonstrate that the different groups will be willing to participate in the market when there is a possibility that corners take place. For simplicity, we do this for the case where $x_n = 0$ so no new supply is introduced at date 1. It is straightforward to see the effect of introducing new supply. A larger x_n will reduce the manipulator's expected profits and increase the arbitrageurs' expected profit.

The uninformed are clearly willing to participate since they obtain the same level of utility whether or not a corner takes place.

The arbitrageurs will recognize that if they take a short position they have a chance of being cornered. They will therefore be prepared to take a short position only if the prospect of gain offsets the chance of being cornered. In other words, it is necessary that their profits from the short position are positive

$$\pi(1 - \varphi)(P - P_C) + (1 - \pi(1 - \varphi))(P - \theta_B) \geq 0. \tag{22}$$

The first term represents the possibility of being cornered. There is a probability $\pi(1 - \varphi)$ that this occurs. The arbitrageur sells the borrowed stock for P at date 0 and has to settle with the manipulator for P_C at date 1. The second term represents the expected profit when the market is not cornered. There is a probability $1 - \pi(1 - \varphi)$ this happens. The arbitrageur sells the stock for P at date 0 and can cover at date 1 for the expected payoff θ_B. Rearranging (22) gives

$$P \geq \pi(1 - \varphi)P_C + (1 - \pi(1 - \varphi))\theta_B = P^*. \tag{23}$$

The equilibrium is shown in Figure 4. For $P^* > P \geq P_2$, there are no short sales. The arbitrageurs get bad news but are unwilling to take a short position. Thus the uninformed must hold all of the risky assets and the arbitrageurs hold nothing. Pooling still occurs though. The uninformed still cannot distinguish between good news and a high x and bad news and a low x, it is just the x is not as low as before. The line marked "Bad News" represents what happens now when the arbitrageurs receive bad news. For $P_1 \geq P \geq P^*$, there are short sales as before. In this region

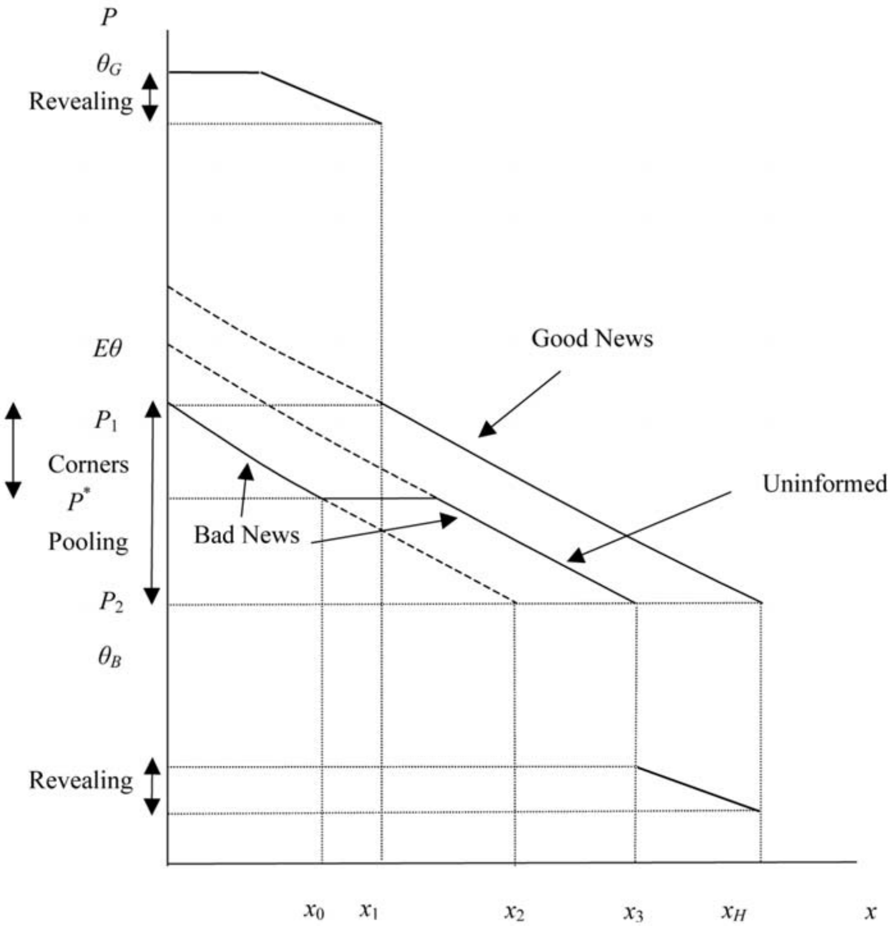


Figure 4. An equilibrium with corners.

there are corners $\pi(1-\varphi)$ of the time. The other change is that the revelation of information near x_H is reduced compared to Figure 3.

A comparison of Figures 3 and 4 demonstrates that the market is less efficient when there is a manipulator who may corner the market. When $\theta = \theta_G$, so there is good news, the price of the risky asset is the same in both figures for all values of x. On the other hand, when $\theta = \theta_B$, so there is bad news, the price is only the same in both cases when $0 \leq x \leq x_1$ and $x_3 \leq x \leq x_H$. For $x_1 \leq x \leq x_3$, the price in Figure 4 is above the price in Figure 3. In other words, the price is farther away from the expected payoff θ_B, so the market is less efficient when the possibility of manipulation exists.

Next consider the manipulator. We assume that the arbitrageurs have taken their short positions with the manipulator. A similar analysis holds if they have taken the short positions with somebody other than the manipulator. Given the manipulator is risk neutral, his expected utility from undertaking the manipulation is

$$EU_M = \pi\{(1-\varphi)0.5[(1-\lambda)X_A^* P_C + X_M\theta_B + X_M\theta_G] + \varphi X_M E\theta - X_M P_M\}. \tag{24}$$

This expression can be understood as follows. There is a probability π that the manipulator will attempt to corner the market and a probability $(1-\varphi)$ that this corner will have the potential to succeed. Half of the time bad news will have been received and in this case the manipulator will be able to force the arbitrageurs to settle at P_C on their shorted stock, $(1-\lambda)X_A^*$. The stock the manipulator purchases from the uninformed, X_M, pays off θ_B on average. The other half of the time good news is received and the X_M the manipulator purchases pays off θ_G. The term $\varphi X_M E\theta$ represents the expected payoff on the stock when the corner does not succeed. The final term $X_M P_M$ is the cost of buying the risky asset from the uninformed.

Rearranging (24)

$$EU_M = \pi\{(1-\varphi)0.5[(1-\lambda)X_A^* P_C] + X_M(E\theta - P_M)\}. \tag{25}$$

Next consider the determination of P_M in (20). Since the first derivative of the left hand side with respect to η is negative, putting $\eta = 0$ increases the left hand side. Denoting the solution for P_M for the case when $\eta = 0$, P_M^*, it can be shown

$$P_M^* = E\theta - \frac{\gamma}{2}\sigma_\varepsilon^2 > P_M. \tag{26}$$

Using this in (25) it follows that $EU_M > 0$ so the manipulator is better off from manipulating the market.

This analysis of the expected utilities of the uninformed, the arbitrageurs and the manipulator shows that corners can occur when everybody is behaving rationally. The uninformed have the same expected utility whether there are corners or not. The arbitrageurs and the manipulator are better off from participating in the market.

The model presented in this section has a number of implications that are considered in the empirical section below. The first part of this investigates the differences between successful and unsuccessful corners. Based on the analysis above the results of this comparison are able to give some insight into the factors that are responsible for corners failing. If it is because the manipulator is unable to buy up the existing floating supply then volume will be higher for successful corners. On the other hand if it is because new floating supply comes on to the market then volume will be higher for unsuccessful corners. In addition it can be seen from Figure 4 that the theory predicts that for successful corners the arbitrageurs will be trading based on their information before a corner occurs. We test whether this is the case or not. Finally, the model suggests that corners only occur when there is bad news. We consider evidence whether or not this is the case in the corners we investigate.

3. Historical Data and Institutional Background

One of the main hurdles in studying market manipulation is that the data are hard to obtain since the activity is often illegal and thus the participants do their best to hide it. Aggarwal and Wu (2006) and Mei et al. (2004) get around this problem by using prosecution cases filed by the SEC. This paper overcomes the hurdle by looking at a special form of manipulation – market corners. We identify market corners by going through the stock market chronology compiled by Wyckoff (1972). He defines a corner as "a market condition brought about intentionally – though sometimes accidentally – when virtually all of the purchasable, or floating, supply of a company's stock is held by an individual, or group, who are thus able to dictate the price when settlement is called". Thus, a corner is an extreme form of short squeeze, when the buy side has almost complete control of all floating shares.

We double check all the corners reported by Wyckoff (1972) using reports by Brooks (1969), Clews (1888), Sobel (1965), Stedman (1905), and Thomas (1989). We eliminate those that cannot be verified independently and we restrict our cases to those that happened between 1863 and 1928, because trading data were not available before 1863. The New York Stock Exchange passed rules to discourage market corners in 1920, after which only one corner was reported (Piggly-Wiggly) while the RCA corner in 1928 was unplanned.[6] This gives a total of thirteen reported cases of stock corners. In addition, we also include the case of the failed silver corner of the Hunt brothers in 1980. The corners considered are shown in Table I.

We hand-collected the data set of price and trading volume from the New York Times and we use the Wall Street Journal to search for information that is missing due to the poor publication quality of historical newspapers. This is a laborious process since we also need to aggregate trade-by-trade information in order to get daily price and trading volume.[7] Based on Wyckoff's definition, we break corners into two categories: successful and failed corners. Successful corners are those where the manipulator controlled almost all of the floating shares during the short squeeze and were able to dictate prices. Failed corners are those where the manipulators attempted but failed to control the large amount of floating shares either because of large amounts of new shares that were brought to the market on the settlement date or because of government action. The corner dates are determined based on either the settlement call made by the manipulators or government action

[6] Strictly speaking, the RCA corner is more like a short squeeze because no settlement was called. The reason we included it is because the manipulator Durant was reported to have controlled the whole float.

[7] Unfortunately, while the New York Times reports every trade for each stock before 1900, the trades were not time-stamped so that we cannot perform microstructure studies.

Table I. The sample of corners

We define the corner date as the date when shares that were sold short are called by the manipulator. Corner dates have been established as found in the references, in particular, Clews (1888), Flynn (1934), Thomas (1989), and Wycoff (1968, 1972). Alongside the corner date we have characterized the outcome of the corner as successful or failed. For the Stutz Motor Company and the Piggly-Wiggly Company, we do not have observations after the corner date, due to the institutional halt in trading for both stocks, shortly prior to the corner date. Instead, for these stocks we report the results only for the period until the end of trading.

Company name	Corner date	Corner status
Harlem		
1863	08/24/1863	Successful
1864	05/17/1864	Successful
Prairie du Chien	11/06/1865	Successful
Michigan Southern	04/04/1866	Successful
Erie Railroads		
March – 1868	03/10/1868	Failed
November – 1868	11/16/1868	Successful
American Gold Coin	09/24/1869	Failed
Erie Railroads, 1872	09/17/1872	Failed
Northwestern	11/23/1872	Successful
Northern Pacific	05/09/1901	Successful
Stutz Motor	04/26/1920	Successful
Piggly Wiggly	03/20/1923	Successful
RCA	03/13/1928	Successful
Silver "Corner", 1980	01/21/1980	Failed

dates. Appendix A provides a brief account of most of the corners while Appendix B provides a graphical depiction of their trading activity around the corner dates.

There are several common features of these corners. First of all, most corners involved the robber-barons of the time, namely, Jay Gould, Daniel Drew, Jim Fisk, Cornelius Vanderbilt, and J. P. Morgan. Many of them were in a special position to exploit unwary investors – in many cases they were corporate officers/insiders as well as large stockholders.[8] Second, manipulators often controlled a huge amount of the common shares, often exceeding the whole float at the time of settlement, which put them in a position to dictate the settlement price to the short sellers. Third, stock prices tend to be discontinuous for cornered stocks, often with large price jumps around the corner date, suggesting major disruptions to an orderly

[8] For example, as director of Erie, Drew had used his position to issue new shares to cover his short position. He also had hidden convertible bonds that were unknown to the market but were convertible to common when he was cornered.

market. Fourth, the amount of wealth controlled by the manipulators was large compared to the market cap of the stock.[9]

The presence of deep-pocketed manipulators makes short-selling an extremely hazardous venture for would-be arbitrageurs. The oldest and most sacred rule of Wall Street at the time was "He who sells what isn't his, Must buy it back or go to prison". As pointed out by Jones and Lamont (2002), there are two main risks for short sellers: first, short sellers are required to post additional collateral if the price of the shorted stock rises. Second, stock loans can be called at the discretion of the lender, giving rise to recall risk.

Manipulation will exacerbate the above risks and add some new risks to the arbitrageurs. First of all, when manipulators are better informed about the supply of shares, the short sellers are more likely to close their position at a loss. The lender of the stock would demand the return of her shares at the worst possible time. The stock lender/ manipulator will call in her loan when the shares have risen in price and the short sellers are unable to find shares to borrow. Second, deep-pocketed manipulators will be able to drive stock prices to the point where short sellers would not be able to post additional collateral and thus have to close their position at a loss. Third, the price jumps during a market corner create a huge operational risk for brokers who arrange stock borrowing for short sellers. In the event of a market corner, large jumps in stock price could easily wipe out the collateral put up by short sellers and lead to severe financial losses for the broker in the event of short seller default.[10] In this case, because of lack of liquidity in the market, it may be difficult for brokers to protect themselves by closing short-sellers' positions.

What institutional features made corners much more prevalent in the 19th century? First, it was easier to take a large short position then. According to John Gordon, at the time "most short sales were effected not by borrowing the stock as is done today, but by using seller's options. Stock was often sold for future delivery within a specified time, usually ten, twenty, or thirty days, with the precise time of delivery up to either the buyer – in which case it was called a buyer's option – or the seller. … These options differed from modern options – puts and calls – in that the puts and calls convey only a right, not an obligation, to complete the contract".[11] Since many short sellers often sold large quantities of naked options, the manipulator, having acquired the float, could force a corner by exercising his buyer's option for immediate delivery and waiting for delivery from those who

[9] According to Gordon (1999), Vanderbilt put together a stock pool of $5 million in cash to operate the second Harlem corner. At the time, he already owned a big chunk of Harlem stocks due to the first Harlem corner. On March 29, 1864, Harlem had a market capitalization of $11.9million with 110,000 shares outstanding. By the end of April, Vanderbilt and his allies owned 137,000 shares, with the difference sold to them by the short sellers. At time of his death in 1877, Vanderbilt left an estate that was worth $90 million.

[10] In the second Harlem corner, Vanderbilt was so furious at the short sellers that he was reported planning to drive the stock price to $1,000. But he dropped his plan after leaning that it would bankrupt almost all brokerage firms on the street. See Clews (1888), chapter 34.

[11] See Gordon (1999, p. 105).

sold the seller's option when the contract was due. Vanderbilt was said to have bought up all floating shares as well as all seller's options during the Hudson River corner.[12]

Second, margin requirements were less restrictive. Prior to 1934 when the Securities Act was enacted, this requirement was negotiated between the brokers and their clients. It could sometimes drop to as low as 10%, which allowed a manipulator to acquire a large block of stocks with relatively little capital.[13] Third, the market was opaque and there was little disclosure of corporate equity information. Thus, the general public had little knowledge about the float of the stock as well as who were the major shareholders and their positions. As a result, the short sellers could have a false sense of security by shorting a stock, not realizing that the float was much smaller than they had thought. Fourth, poor transportation made it difficult for out of town and overseas investors to bring their shares to the market, effectively taking those shares out of the float.[14] According to Sobel (1988), foreigners owned $243 million of railroad securities in 1869. Fifth, the legal system was much less independent and judges could often be bribed to issue injunctions to restrict the issue of new shares.[15] By controlling the supply of shares, it made it easier for the manipulator to achieve a corner. Finally, there was a blatant disregard for conflict of interest and minority shareholder rights. Directors often took advantage of their position to manipulate stock price. Because of their ability to restrict the supply of shares, this made corners much more likely to happen in the 19th century.[16]

Several legal and regulatory developments made corners more difficult. First, early on in our sample period the NYSE and Open Board rule of Nov. 30, 1868 required corporations to register all securities sold at the exchange and provide thirty-day notice on any new issues.[17] Thus, the float of a company's stock became much more transparent. Second, the legislative committee of the NYSE launched an investigation of corners, indicating an increasing concern of the members on the negative impact of corners on market transactions.[18] Third, the 1934 Securities Act imposed a mandatory margin requirement, which increased the capital needed for acquiring a large block of stocks. Fourth, the 1968 Williams Act required the filing by any person or group of persons who have acquired a beneficial ownership of more than five percent of equity of certain issuers within ten days of such an acquisition. This brings transparency to the ownership position of large shareholders. Lastly, the Governing Committee of the New York Stock Exchange delisted Stutz Motor after its corner in 1920, effectively voiding the contract between short sellers

[12] See Gordon (1999, pp. 105–106).
[13] See Wyckoff (1972, p. 239).
[14] See Sobel (1988, p. 161).
[15] See Sobel (1988, pp. 154–196) and Gordon (1999, p. 116).
[16] See Gordon (1999, p. 114).
[17] See Gordon (1999, p. 124).
[18] See Wyckoff (1972, p. 29).

and the manipulator. Moreover, delisting prevented manipulators from unwinding their position at the stock exchange after the corner.[19] While manipulators may still profit from the high prices short-sellers have to pay for the borrowed shares, they lose the liquidity to sell their vast holdings afterwards. As a result, the Stutz motor corner was essentially the last intentional corner at the New York Stock Exchange.[20]

4. Empirical Results

The data for this study is collected from historical records of the New York Times and The Wall Street Journal (see Table I for the corresponding time periods). Nine of the documented corners took place in the second half of the nineteenth century and five took place throughout the twentieth century. A concise historical reference on each of these corners is presented in Appendix A. In the process of building the historical trading database we have aggregated intra-day transactions on a daily basis.

We start with brief descriptive statistics for the companies in our sample. We examine daily returns, volatility, autocorrelation, price dispersion, and trading volume. We conduct this analysis for the pre-corner period, as well as in two corner sub-periods: corner period one – ten days before the corner to the corner date (included), and corner period two – the day after the corner date to ten days following it. We present descriptive statistics for the returns for these periods in Table II.[21] Notice that there is a significant increase in daily returns during corner period one (3.6%) as compared to the pre-corner period (0.4%), and a subsequent decline in returns in corner period two (−2.7%). One notable example is the Northwestern market corner – in the first corner sub-period daily returns were 9.3% on average, while in the post-corner period the average daily return was −9.7%. The return is continuously compounded for the duration of the corner period and is computed using the closing price.

There is a significant increase in the volatility of returns in both corner periods (7.3% for corner period one, and 6.7% for corner period two) as compared with the pre-corner period (3%). Another indicator of interest is the increased price dispersion (7.1% for corner period one, and 4.3% for corner period two as compared to the periods before the corner 3.1%). Price dispersion is defined as the daily spread between high and low as a percentage of the close price. The evidence on the impact of the market corner on price dispersion is consistent with the hypothesis that there exists significant private information trading in the run-up to the corner as predicted by our model – as a result the price dispersion increases in the first

[19] See Gordon (1999, pp. 217–218) and Brooks (1969, pp. 29–33).

[20] See Wyckoff (1972, p. 72).

[21] The pre-corner period has been standardized to have the length of 55 trading days, i.e., we define it as $[t-65, t-10)$. All of our results are robust to alternative pre-corner period length specification, e.g., 40 days as in $[t-65, t-25)$ and correspondingly corner period one in $[t-25, t]$.

Table II. The returns, price dispersion, and trading volume around corners

The corner period is defined as $[t - 10, t + 10]$ days around the corner date, t, a total of twenty-one days, including the corner date. The number of observations reflects the number of non-missing daily return observations. Return is defined as the continuously compounded return computed from the close price. Share volume is defined as the total number of shares traded in the corresponding trading day. Daily turnover is defined as the ratio of the total number of shares traded divided by the total number of outstanding shares. Autocorrelation refers to the autocorrelation of returns computed within the corresponding period (differs across panels A, B, and C), $\rho_t = \mathrm{corr}(R_t, R_{t-1})$. Price dispersion refers to the difference between high and low, scaled with the close price for each trading day. For Stutz Motor, we have defined the corner period starting date as 10 days prior to the decision to halt the trading of the company stock, since its corner date is after the official halt of trading. The pre-corner period is defined as the period the sixty fifth day through the eleventh day before the corner date. The first corner sub-period is defined as the period ten days before the corner date until the corner date (included). The second corner sub-period is defined as the period from the first day following the corner to the tenth day following the corner date.

Panel A: Pre-corner period, $[t - 65, t - 10]$

		Daily return		Daily price dispersion	Daily shares traded	Daily turnover		Daily autocorr.		
	N	Mean	Std. dev	Mean (%)	Std. dev (%)	Mean	Std. dev	Mean	Std. dev	$\rho_{1,cs}$
Harlem, 1863	54	0.006	0.060	4.2%	3.9%	11,232	8,070	0.102	0.073	−0.177
Harlem, 1864	55	0.010	0.054	5.1%	3.8%	10,888	8,579	0.099	0.078	−0.200
Prairie du Chien	55	0.008	0.030	2.5%	2.0%	1,280	1,249	0.043	0.042	0.040
Michigan Southern	55	0.003	0.018	3.4%	6.8%	12,355	4,794	–	–	−0.379
Erie, 03 – 1868	53	−0.002	0.015	1.8%	1.4%	17,214	9,504	0.297	0.164	0.102
Erie, 11 – 1868	55	−0.002	0.028	2.8%	1.5%	7,671	7,692	0.038	0.038	0.194
Gold Coin, 1869	55	0.000	0.005	–	–	–	–	–	–	0.143
Erie, 1872	53	−0.002	0.026	5.2%	17.0%	19,360	13,490	0.117	0.081	−0.145
Northwestern	54	0.002	0.031	2.6%	2.2%	18,908	16,693	0.105	0.092	−0.411
Northern Pacific	55	0.004	0.014	1.9%	1.3%	37,714	33,413	0.047	0.042	−0.125
Stutz Motor	55	0.008	0.039	3.1%	3.2%	976	1,002	0.010	0.010	0.203
Piggly Wiggly	55	0.006	0.035	2.1%	1.6%	2,175	2,139	0.011	0.011	−0.215
RCA	55	0.000	0.022	3.1%	1.4%	75,596	49,872	0.065	0.043	−0.033
Silver “Corner”	54	0.011	0.040	2.3%	2.1%	7,263	4,895	–	–	−0.076
Mean	**55**	**0.004**	**0.030**	**3.1%**	**3.7%**			**0.085**		**−0.077**

Table II. The returns, price dispersion, and trading volume around corners (continued)

Panel B: Corner-period, $[t-10, t]$									
	Daily return		Daily price dispersion		Daily shares traded		Daily turnover		Daily autocorr.
	Mean	Std. dev	Mean (%)	Std. dev (%)	Mean	Std. dev	Mean	Std. dev	$\rho_{1,cs}$
Harlem, 1863	0.019	0.041	3.2%	1.7%	8,459	4,092	0.077	0.037	0.131
Harlem, 1864	0.018	0.031	1.0%	1.5%	773	672	0.007	0.006	−0.194
Prairie du Chien	0.095	0.216	14.2%	15.1%	3,944	1,905	0.132	0.064	−0.243
Michigan Southern	0.009	0.014	4.9%	3.7%	14,174	7,765	–	–	−0.020
Erie, 03 – 1868	0.009	0.031	4.2%	2.4%	24,462	14,648	0.422	0.253	0.026
Erie, 11 – 1868	0.021	0.081	5.1%	2.9%	14,402	18,573	0.072	0.093	0.713
Gold Coin, 1869	−0.002	0.025	–	–	–	–	–	–	−0.285
Erie, 1872	0.006	0.024	4.4%	3.2%	23,600	14,332	0.142	0.086	−0.298
Northwestern	0.093	0.169	11.4%	19.2%	7,536	5,648	0.042	0.031	0.525
Northern Pacific	0.102	0.210	22.0%	47.2%	119,185	112,599	0.149	0.141	0.522
Stutz Motor	0.066	0.050	7.3%	2.9%	3,585	1,971	0.036	0.020	−0.243
Piggly Wiggly	0.005	0.069	8.7%	17.8%	3,982	6,668	0.020	0.033	−0.119
RCA	0.039	0.053	5.7%	4.4%	194,045	127,331	0.168	0.110	0.671
Silver “Corner”	0.023	0.013	0.0%	0.0%	9,347	5,379	–	–	−0.059
Mean	**0.036**	**0.073**	**7.1%**	**9.4%**			**0.115**		**0.081**

Table II. The returns, price dispersion, and trading volume around corners (continued)

Panel C: Corner-period two, $[t+1, t+10]$

	Daily return		Daily price dispersion		Daily shares traded		Daily turnover		Daily autocorr.
	Mean	Std. dev	Mean (%)	Std. dev (%)	Mean	Std. dev	Mean	Std. dev	$\rho_{1,cs}$
Harlem, 1863	−0.032	0.037	4.8%	5.3%	6,681	2,971	0.061	0.027	0.672
Harlem, 1864	0.000	0.007	0.3%	0.4%	375	210	0.003	0.002	−0.412
Prairie du Chien	−0.056	0.149	2.3%	4.7%	526	468	0.018	0.016	−0.196
Michigan Southern	−0.011	0.020	3.5%	7.4%	6,600	5,046	–	–	0.062
Erie, 03 – 1868	−0.004	0.029	3.0%	1.7%	16,003	8,450	0.101	0.053	0.394
Erie, 11 – 1868	−0.025	0.029	10.9%	12.2%	6,803	8,065	0.034	0.040	−0.193
Gold Coin, 1869	−0.002	0.009	–	–	–	–	–	–	−0.033
Erie, 1872	−0.006	0.032	6.1%	3.8%	20,236	14,824	0.122	0.089	−0.064
Northwestern	−0.097	0.183	4.7%	10.9%	2,222	2,176	0.012	0.012	0.321
Northern Pacific	−0.071	0.251	3.6%	2.9%	938	660	0.001	0.001	−0.748
Stutz Motor	–	–	–	–	–	–	–	–	–
Piggly Wiggly	–	–	–	–	–	–	–	–	–
RCA	0.003	0.047	7.0%	3.4%	98,040	71,110	0.085	0.062	−0.154
Silver "Corner"	−0.019	0.015	0.7%	1.2%	5,097	4,255	–	–	−0.309
Mean	**−0.027**	**0.067**	**4.3%**	**4.9%**			**0.049**		**−0.055**

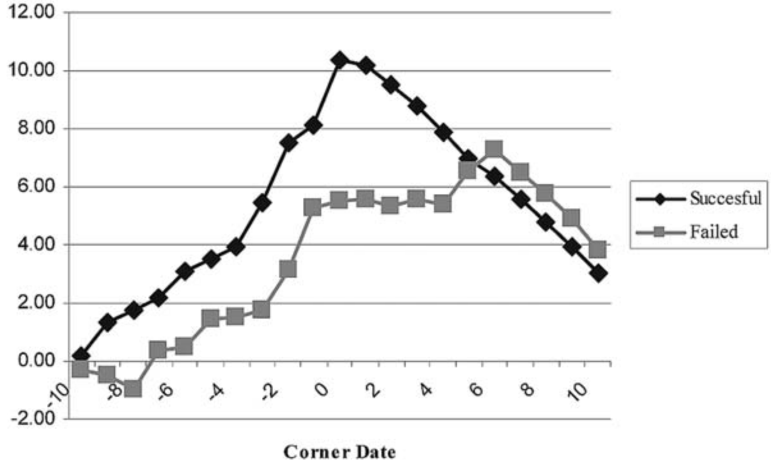


Figure 5. Cumulative abnormal trading volume (standardized). Abnormal trading volume is defined as the difference between daily volume in the corner period and the pre-corner period *average* daily trading volume. We standardize this variable with the standard deviation of the pre-corner period daily volume. In the figure, we have accumulated the trading volume across the corner period, i.e., at date $t - 10$ we have plotted the abnormal trading volume at that day, at date $t - 9$ we have plotted the sum of the variable values at dates $t - 10$ and $t - 9$, etc.

period preceding the corner, while it substantially decreases in the period after the corner. For example, in the corner of Northern Pacific price dispersion prior to the corner period is on average 1.9% daily. However, in the first corner sub-period, the price dispersion increases to 22% only to retreat to the low 3.6% following the corner.

Table II also shows a significant change in trading volume between the pre-corner and the corner periods. For example, the average daily share volume has increased between pre-corner period to corner period one from 75,596 shares for RCA to 194,045 or from 37,714 to 119,185 for Northern Pacific, or from 7,671 to 14,402 for the second Erie corner. Even more dramatic was the dry-up of liquidity after the corner date for some stocks, e.g., a decrease from 119,263 shares in corner period one to 938 shares in corner period two for Northern Pacific. Figure 5 provides plots of changing liquidity (we use cumulative abnormal trading volume as a proxy). The abnormal trading volume is defined as the difference between daily volume in the corner period and *average* daily trading volume in the pre-corner period. We standardize this variable with the standard deviation of the pre-corner period daily volume. In the figure, we have accumulated the trading volume across the corner period, i.e., at day $t - 10$ (i.e., ten days prior to the corner date) we have plotted the abnormal trading volume at that date; at day $t - 9$ we have plotted the sum of the abnormal trading volume at days $t - 10$ and $t - 9$, etc.

A clear pattern of increased turnover and subsequent gradual decrease is displayed in Figure 5. However, the pattern of liquidity impact differs across successful and failed corners, being more pronounced for the successful corners as compared to the failed ones. This is consistent with the hypothesis that successful market corners have a considerable impact on the liquidity of the cornered stock. As discussed in Section 2 it also suggests that corners failed due to an inability to purchase all the floating supply rather than because of new shares being added to the floating supply.

We further tabulate in Table II the turnover around the corner events. Daily turnover is defined as the ratio of the total number of shares traded divided by the total number of outstanding shares.[22] Comparing Table II, panels A and B, there is an increase in the average daily turnover between the pre-corner period and corner period one (from 0.085 to 0.115). However, a Wilcoxon test of the equality of the means of the average turnover in pre-corner period and in corner period one cannot reject the null hypothesis of equality of the means (p-value is 0.53). Similarly, comparing panels B and C of Table II, there is a decrease in the average daily turnover in the corner period two (0.049) as compared with corner period one (0.115). A Wilcoxon test of equality of the means of corner period one and corner period two rejects the null hypothesis of equality of the means at the 10% significance level (p-value is 0.07). One caveat in our interpretation of turnover results above is that the available float may be much smaller than the outstanding float. Thus, such comparisons of daily turnover before and during the corner event might be difficult to interpret.

We also analyze autocorrelation patterns in Table II. Daily price changes should be serially uncorrelated if a market is efficient. There seems to be a significant change in autocorrelation of returns between pre-corner and corner periods. In the first corner period we observe on average a positive autocorrelation of 8.1%, as compared with the second corner sub-period, where the autocorrelation is -5.5%. The pre-corner autocorrelation is -7.7%. The pattern of autocorrelation within the corner period one is suggestive of the presence of informed trading in the sense of Llorente et al. (2002). This is investigated further below.

One of the predictions of our theoretical model is that corners would have a large impact on liquidity. To test this prediction, we have examined in Table III the properties of a measure of illiquidity, similar to the one in Amihud (2002):

$$ILLIQ_{i,t} = |R_{i,t}|/VOLD_{i,t}, \tag{27}$$

where $VOLD_{i,t}$ is the daily dollar trading volume (in million of dollars) for corner stock i in day t, adjusted for inflation.[23] Higher values of this measure indicate

[22] We are able to retrieve historical data on the outstanding shares for all companies except Michigan Southern. There are two cases where the corner event was followed by a stock issue. In the case of Erie market corner of March 1868 there were 100,000 new shares issued immediately after the corner date. In the case of the Erie market corner of November 1868 there were records of several fraudulent over-issues of that stock, see New York Times as of 03/10/1868 and 11/16/1868.

[23] For all stocks $VOLD_{i,t}$ is defined as the product of the close price and the number of shares traded (in millions), adjusted for inflation. For the NYMEX 5000 oz silver futures contracts, we define it as: $VOLD_{silver,t} = N_t \times 5000 \times P_t/10^8$, where N_t is the number of futures contracts

lower liquidity, i.e., little trading volume leads to more significant stock price changes (the average correlation of the illiquidity measure and the standardized abnormal volume over $[t-10, t+10]$ is -0.27). The results in Table III indicate that on average there is a decrease in liquidity after the corner date, where this effect is stronger for successful corners.[24] We illustrate this pattern in Figure 6, where we display the average daily illiquidity measure across successful and failed corner stocks,

$$AILLIQ_t = \frac{1}{N}\sum_{i}^{N}|R_{i,t}|/VOLD_{i,t}.^{25}$$

The figure shows the increased illiquidity following the corner date, with greater illiquidity for the successful corners.

In Table IV we present a comparison of successful and failed corners. The comparison is based on standardized abnormal trading volume, price dispersion, stock illiquidity (defined in (27)), an abnormal illiquidity measure (defined below), excess returns, and market-adjusted returns. The table records coefficient estimates and corresponding t-statistics, based on a regression of each of the above variables on a constant, where we use the Newey-West correction to address autocorrelation-in-residuals concerns for the corner period 1 and for the corner period 2.

traded in day t, and P_t is the close price (in cents per ounce) as of trading day t. We translate this measure into millions US dollars and adjust it for inflation in order to make it comparable across corners which occur in different time periods. The adjustment is based on the inflation conversion factors for the US dollar from 1863 to 1980 which we obtain from Robert Sahr, at http://oregonstate.edu/dept/pol_sci/fac/sahr/sahr.htm. We express dollar values in US dollars as of 1900.

[24] There are two caveats associated with this measure. The first one is that we could not compute it for days with zero trading volume. Second, this measure is very sensitive to changes in volume when the level of trading volume is low. For example, Prairie du Chien has substantially higher $ILLIQ_t$ in the post-corner period as compared to the other corner stocks, partly because of the thin trading of its stock.

[25] Note that in Figure 6 we have excluded the observations for Prairie du Chien. Due to its low trading volume in the second corner period, the illiquidity measure for that stock is substantially higher than the illiquidity measures for the rest of our sample corner stocks. The conservative approach we follow would bias our results against finding support for our hypothesis that liquidity would decrease after the corner event and would further ascertain that our results are not driven by outliers.

Table III. Illiquidity measure for corner stocks

The illiquidity measure is defined as in Amihud (2002), where $ILLIQ_{i,t} = |R_{i,t}|/VOLD_{i,t}$ is the daily dollar trading volume (in million of dollars), adjusted for inflation in order to make it comparable across different corner periods. Day zero (i.e., t) is the day of the corner. For Stutz Motor, day zero is defined as the day when the NYSE halted trading in that stock. For the Stutz Motor and Piggly Wiggly corners, trading was halted prior or upon the corner occurrence. The missing observation at $t = 5$ for Prairie du Chien corner is due to no trading on that day.

	Day t																				
	−10	−9	−8	−7	−6	−5	−4	−3	−2	−1	0	1	2	3	4	5	6	7	8	9	10
Successful Corners																					
Harlem, 1863	0.12	0.00	0.01	0.06	0.05	0.09	0.07	0.03	0.05	0.02	0.01	0.03	0.02	0.02	0.01	0.03	0.02	0.04	0.04	0.25	0.08
Harlem, 1864	0.04	0.38	0.91	0.43	0.00	0.53	0.16	0.18	0.32	0.05	0.00	0.00	0.66	0.32	0.08	0.00	0.00	0.04	0.08	0.12	0.12
Prairie du Chien	0.42	0.31	0.00	0.39	0.26	0.05	0.50	0.67	0.55	2.35	1.12	0.82	13.73	18.80	6.24	–	34.45	0.60	0.20	0.00	0.00
Michigan Southern	0.01	0.00	0.01	0.00	0.04	0.01	0.02	0.01	0.06	0.06	0.01	0.05	0.13	0.03	0.03	0.02	0.07	0.02	0.02	0.06	0.02
Erie, 11 – 1868	0.36	0.01	0.04	0.04	0.05	0.03	0.09	0.23	0.12	0.27	0.11	0.08	0.14	0.06	0.28	0.59	0.31	0.58	2.65	0.71	0.75
Northwestern	0.05	0.03	0.06	0.01	0.15	0.01	0.03	0.12	0.04	0.54	0.26	0.22	0.54	3.17	0.25	0.07	0.28	0.21	0.04	1.70	0.00
Northern Pacific	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.20	2.07	0.36	0.44	0.38	0.09	1.02	0.53	0.04	0.13	0.25
Stutz Motor	0.18	0.18	0.06	0.36	0.02	0.25	0.14	0.23	0.08	0.33	0.36	–	–	–	–	–	–	–	–	–	–
Piggly Wiggly	0.12	0.05	0.05	0.34	0.36	0.18	0.19	0.88	0.55	1.33	0.14	–	–	–	–	–	–	–	–	–	–
RCA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00
Mean	**0.13**	**0.10**	**0.12**	**0.16**	**0.09**	**0.12**	**0.12**	**0.24**	**0.18**	**0.50**	**0.22**	**0.41**	**1.95**	**2.86**	**0.91**	**0.12**	**4.52**	**0.25**	**0.38**	**0.37**	**0.15**
St. Dev.	**0.15**	**0.14**	**0.28**	**0.19**	**0.12**	**0.17**	**0.15**	**0.30**	**0.22**	**0.77**	**0.34**	**0.72**	**4.77**	**6.53**	**2.16**	**0.21**	**12.10**	**0.27**	**0.92**	**0.58**	**0.26**
Failed Corners																					
Erie, 03 – 1868	0.01	0.01	0.02	0.01	0.06	0.02	0.02	0.04	0.01	0.02	0.01	0.02	0.05	0.03	0.06	0.03	0.02	0.06	0.06	0.02	0.01
Gold, 1869	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Erie, 1872	0.09	0.00	0.05	0.04	0.04	0.03	0.01	0.03	0.04	0.02	0.02	0.02	0.01	0.05	0.00	0.03	0.05	0.09	0.05	0.01	0.04
Silver “Corner”, 1980	0.01	0.01	0.01	0.00	0.02	0.01	0.01	0.01	0.01	0.00	0.27	0.01	0.01	0.01	0.01	0.01	0.01	0.04	0.41	0.01	0.04
Mean	**0.04**	**0.01**	**0.03**	**0.02**	**0.04**	**0.02**	**0.01**	**0.03**	**0.02**	**0.01**	**0.10**	**0.02**	**0.02**	**0.03**	**0.03**	**0.03**	**0.03**	**0.07**	**0.17**	**0.01**	**0.03**
St. Dev.	**0.04**	**0.00**	**0.02**	**0.02**	**0.02**	**0.01**	**0.00**	**0.02**	**0.02**	**0.01**	**0.15**	**0.01**	**0.03**	**0.02**	**0.03**	**0.01**	**0.02**	**0.03**	**0.21**	**0.01**	**0.02**

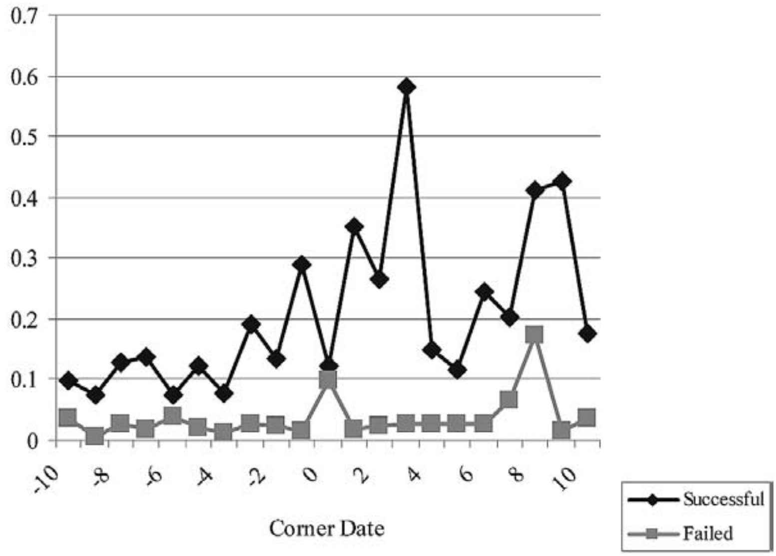


Figure 6. Average daily illiquidity measure for corner stocks. We define the average daily illiquidity measure across successful and failed corner stocks as $AILLIQ_t = 1/N \sum_i^N |R_{i,t}|/VOLD_{i,t}$, where $VOLD_{i,t}$ is the daily dollar trading volume (in million of dollars), adjusted for inflation, $R_{i,t}$ is the daily return for stock i, and t indexes trading days (see Amihud (2002)). We exclude Prairie du Chien, due to its low trading volume that leads to exceedingly high levels of the illiquidity measure for that company.

We start with a discussion of the excess returns around the corner event.[26] In the period $[t-10, t]$ we observe statistically significant average daily excess returns for successful corners of 4%. The excess returns are positive for failed corners too and are statistically significant, albeit of lower magnitude (1%). After the corner date, strikingly, the successful corner stocks give back all excess return gains. Failed corners follow that pattern of post-corner negative returns, too, but the drop is less dramatic. The above findings are also illustrated in Figure 7. Successful and failed corner stocks follow different patterns: the cumulative excess returns for successful corners peaked at the day of the corner to 45% above the pre-corner market return

[26] The daily excess return is defined as the residual of the Black version of the CAPM model within the corner period, where the CAPM coefficients have been estimated from the pre-corner period. The reason we use the Black version of the CAPM is the lack of availability of a risk free rate for most of the periods considered. In particular we have retrieved the residuals from the following regression: $R_{i,t} = \alpha + \beta R_{m,t} + \varepsilon_t$, estimated from the pre-corner period, where R_i is the company/security i return, and R_m is the market return. For Erie Railroad, Harlem, Northwestern, Prairie du Chien, Michigan Sourthern, and the American Gold Coin, we compute the market return as the daily equally-weighted stock return average where the individual stock returns have been collected from the *New York Times*. For Northern Pacific we use as market return the daily return on the Dow Jones Transports/Rails index. For Stutz Motor, Piggly Wiggly, RCA, and the silver futures on COMEX, we used the daily market return on the Dow Jones Industrial Average index.

Table IV. Successful vs. failed corner stocks using standardized abnormal volumes, price dispersion, illiquidity measures, excess returns and market-adjusted returns

The table presents estimates from a regression of the corresponding variable for the sample corner stocks on a constant, where we have used the Newey-West correction for autocorrelation in residuals. Standardized abnormal volume is defined as the daily share volume in the *corner period* in excess of the average daily share volume in the *pre-corner period*, divided by the standard deviation of the *pre-corner* daily share volume, shown in Table II. Price dispersion is the daily spread between high and low as a percentage from the close price for the corner stocks. The illiquidity measure is defined in (27). We exclude Prairie du Chien when computing the illiquidity measure due to its low trading (this biases us against finding support for our hypothesis). The abnormal illiquidity measure is defined as the daily illiquidity measure from (27) in the *corner period* in excess of the average daily illiquidity measure in the *pre-corner period*. The daily excess return is defined as the residual of the Black version of the CAPM model within the corner period, where the CAPM coefficients have been estimated from the pre-corner period. Daily market-adjusted return is computed as the average of the difference of the stock and market return. In parentheses below the averages we present their t-statistics.

	Corner Period 1, $[t-10, t]$		Corner Period 2, $[t+1, t+10]$	
	Successful	Failed	Successful	Failed
Average Daily standardized abnormal volume	0.94	0.50	−0.73	−0.17
T-stat	(3.6)	(2.28)	(−7.31)	(−0.82)
Average Daily price dispersion (%)	8.4%	2.9%	4.6%	3.3%
T-stat	(4.47)	(4.46)	(4.88)	(4.33)
Average Amihud (2002) illiquidity measure	0.13	0.03	0.29	0.04
T-stat	(5.58)	(3.51)	(3.98)	(3.33)
Average Abnormal illiquidity measure	−0.07	0.01	0.24	0.02
T-stat	(−1.75)	(0.73)	(3.34)	(1.50)
Average Daily excess return	0.04	0.01	−0.04	−0.01
T-stat	(3.4)	(1.98)	(−2.53)	(−2.29)
Average Daily market-adjusted return	0.05	0.01	−0.04	−0.01
T-stat	(3.77)	(3.04)	(−2.36)	(−1.56)

while returns for the failed corner are relatively flat at 8% on the corner date in Figure 7.

One concern in the computation of the excess returns above is that the pre-corner period may contain manipulation activity. We would expect that this would bias our estimates since we use the pre-corner period to compute market betas, and averages of the stock returns and stock volumes. To address this concern, we also exhibit in Table IV market-adjusted returns, computed by subtracting market returns from the raw returns in the corner period. The results are quite similar. The average daily market returns in the first corner sub-period are statistically significant and positive for both failed and successful corners; they are negative in the

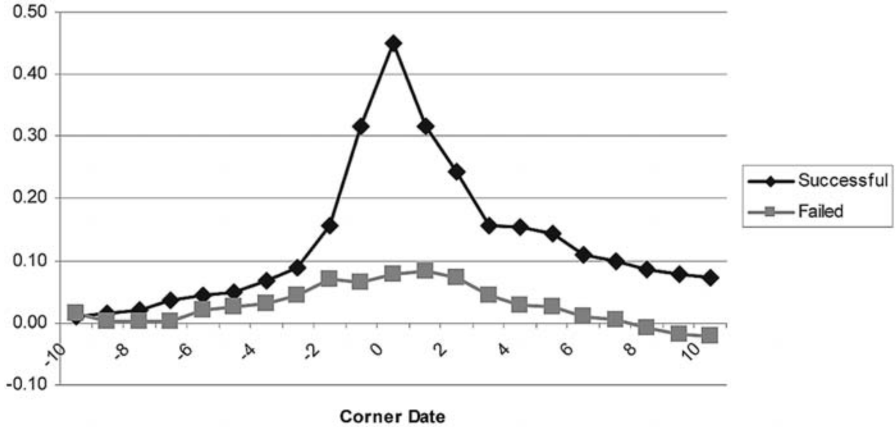


Figure 7. Cumulative excess returns. We exhibit the cumulative excess returns for corner stocks. Excess return is defined as the residual of the regression: $R_{i,t} = \alpha + \beta R_{m,t} + \varepsilon_t$, estimated for the pre-corner period, where R_i is the company i return, and R_m is the market return. For Erie Railroad, Harlem, Northwestern, Prairie du Chien, Michigan Sourthern, and the American Gold Coin, we compute the market return as the daily equally-weighted stock return average where the individual stock returns have been collected from the *New York Times*. For Northern Pacific we use as market return the daily return on the Dow Jones Transports/Rails index. For Stutz Motor, Piggly Wiggly, RCA, and the silver futures on COMEX, we used the daily market return on the Dow Jones Industrial Average index.

second corner sub-period. The order of magnitude of the average market-adjusted returns is similar to the one of the average excess returns.

Before the corner date, there is a significant rise in the abnormal volume of successful corner stocks, 0.94 standard deviations above the pre-corner average daily volumes. We observe the same result for failed corner stocks, but by lower magnitude, 0.50. Strikingly, after the corner date we observe a sharp fall in trading volume, especially for successful corner stocks (0.73 standard deviations below the pre-corner average daily volumes).

Price dispersion increases before the corner especially for successful corner stocks, by 8.4%. A similar increase is observed for failed corner stocks, but by less, 2.9%. The price dispersion decreases following the corner for successful corners (4.6%), but it increases slightly for failed corners (3.3%). This pattern of increased price dispersion (reflective of information trading) is also displayed in Figure 8. The successful corner stocks have higher daily price dispersion compared to the failed ones, reaching 36.2% on the date of the corner (for failed corners the price dispersion is 5.5%). The large price dispersion in the case of successful corners is indicative of the presence of private information trading and it reflects the volatile nature of market corners.

We also study in Table IV the stock illiquidity around the corner date. We define stock illiquidity as in Equation (27). We exclude Prairie du Chien when computing the illiquidity measure due to its low trading volume (low trading volume results in

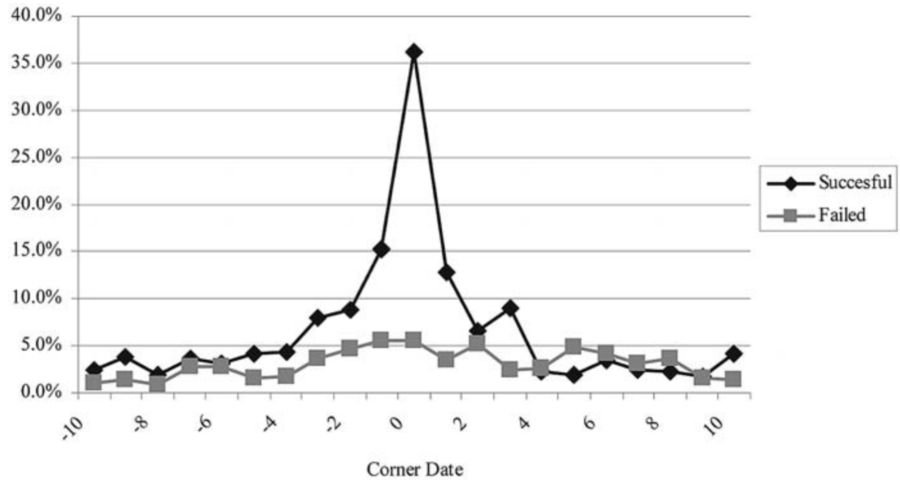


Figure 8. Daily price dispersion (high-low) as a percentage of closing prices. Daily price dispersion is the difference between the high and low prices within a given trading day as a percentage of the close price.

exceedingly high values of the illiquidity measure). This biases us against finding support for our hypothesis of strong impact of the corner event on liquidity. The results in Table IV indicate that there is an increase in the illiquidity measure after the corner for both successful and failed stocks. The increase is more than two fold for successful corners: from 0.13 in the first corner sub-period to 0.29 in the second corner sub-period. Similarly, we observe an increase in the illiquidity for failed corners, but by lower magnitude: from 0.03 in the first corner sub-period to 0.04 in the second sub-corner period. Successful corners are subject to substantially higher illiquidity following the corner as compared to failed ones. We further report a measure of abnormal illiquidity, defined as the average of the daily illiquidity measure from Equation (27) in the *corner period* in excess of the average daily illiquidity measure in the *pre-corner period*. When computing abnormal illiquidity we still exclude Prairie du Chien from the calculation, due to its low trading volume. Based on the abnormal illiquidity measure, it appears that illiquidity for failed corners within corner periods one and two is not statistically different from the pre-corner value. The illiquidity for successful corners for corner period one is statistically significantly lower than the illiquidity from the pre-corner period. The illiquidity for successful corners in corner period two is statistically significantly higher than the illiquidity in the pre-corner period. This demonstrates the ability of the manipulator in successful corners to withhold the acquired free float after the corner date, while at the same time make it freely available in the corner period one.

In Table V we present daily market returns in the period $[t - 10, t + 10]$ around the corner date. For Harlem, Prairie du Chien, Michigan Southern, Erie, Northwestern, and American Gold Coin we use as the market return the return on

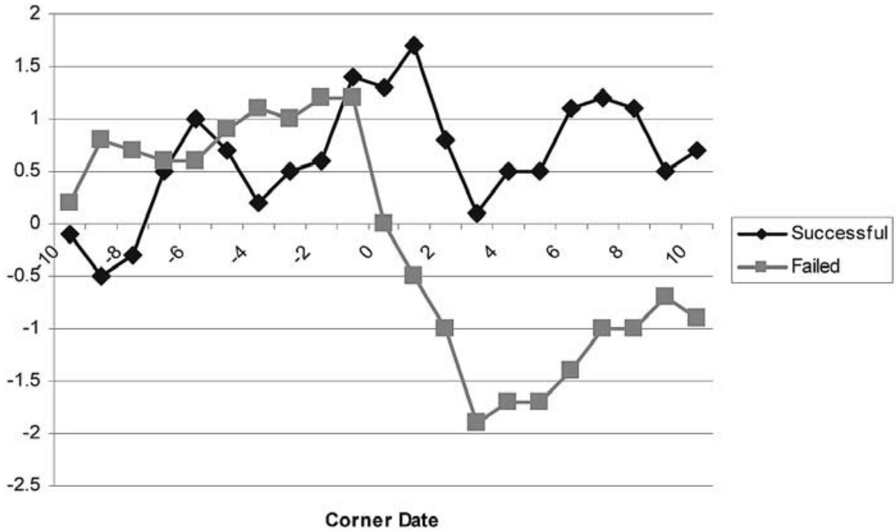


Figure 9. Cumulative market return around corner date. We exhibit the cumulative market return for all corner securities. In the figure, we have accumulated the market return across the corner period, i.e., at date $t - 10$ we have plotted the market return at that day, at date $t - 9$ we have plotted the sum of the market returns at dates $t - 10$ and $t - 9$, etc.

the equally weighted stocks returns, which was hand-collected from the Financial Affairs section of the *New York Times* for the corresponding time period. At the time, the companies included in that section were predominantly railroads. For Northern Pacific we use the Dow Jones Transports/ Rails Index. For Stutz Motor, Piggly Wiggly, and RCA we use the Dow Jones Industrials index. For the silver corner, we use the Dow Jones Industrial Average Index. Daily returns are presented in percentage value.

Results on market return are mixed. On average, the days following the corner had some of the largest decreases in returns. This spillover effect of the corner on the market return is perhaps due to the fact that short-sellers pressed for liquidity might start a fire sale of their portfolios thus causing an overall decline of market returns. The effect seems to be transient since the market generally rebounded by the fourth day after the corner. Furthermore, we could see a pronounced increase in market volatility in the $[t - 1, t + 1]$ period around the corner date. This increase is more pronounced for successful corner stocks as compared to failed corner stocks.

The results from Table V are further illustrated in Figure 9 where we have presented the cumulative market return around the corner date. As discussed above the impact of successful corners on market returns seems to be transient. However, the impact of failed corners on market returns seems to be more pronounced and persistent.

In Table VI, we present a test of whether there is trading on private information as in our theoretical model, based on the dynamic return-trading volume relation-

Table V. Market daily return around corner dates

We present the daily market returns in the period $[t-10, t+10]$ of the corner date. For Harlem, Prairie du Chien, Michigan Southern, Erie, Northwestern, and American Gold Coin we use as market return the return on the equally weighted stocks returns hand collected from the Financial Affairs section of the *New York Times*, for the corresponding period. At the time, the companies included in that section were predominantly railroads. For Northern Pacific we use the Dow Jones Transports/ Rails Index. For Stutz Motor, Piggly Wiggly, and RCA we use the Dow Jones Industrials index. For the silver corner, we use the Dow Jones Industrial Average Index. Daily returns are presented in percentage value.

	Day *t*																				
	−10	−9	−8	−7	−6	−5	−4	−3	−2	−1	0	1	2	3	4	5	6	7	8	9	10
	%																				
Successful Corners																					
Harlem, 1863	−0.8	0.4	2.6	1.9	2.1	−0.3	−0.1	1.3	−0.2	0.0	1.8	0.2	−1.2	−0.3	0.0	0.9	−0.3	−1.0	−2.5	−6.2	0.9
Harlem, 1864	−2.0	−2.0	2.0	−0.1	2.3	1.3	1.2	−0.7	1.3	3.1	0.1	1.9	−2.4	0.1	1.8	−0.9	0.5	0.5	−0.5	−0.7	−0.1
Prairie du Chien, 1865	0.7	−0.1	0.7	1.3	0.5	−0.1	−0.5	0.5	−0.7	2.5	0.0	−1.4	0.4	−0.6	−0.5	−0.1	0.9	0.6	0.1	0.1	0.9
Michigan Southern, 1866	0.3	−0.2	−0.1	0.1	0.2	−0.3	−0.5	−0.8	0.4	0.1	0.6	−0.8	0.5	0.2	0.0	0.5	0.5	0.6	2.6	−1.3	0.5
Erie, 11 – 1868	−2.4	−3.0	−2.5	3.5	0.0	−0.8	0.2	−0.8	−0.5	3.5	0.7	−1.6	1.3	−0.7	−0.3	−0.5	1.4	−0.7	0.6	1.3	0.0
Northwestern, 1872	2.0	−0.3	−0.4	−0.2	0.7	−0.3	−0.4	1.4	0.8	3.3	0.9	0.9	−5.1	0.7	−0.1	0.1	0.1	−0.1	0.1	0.5	−0.8
Northern Pacific, 1901	0.7	1.7	0.6	1.3	−0.1	−1.3	0.3	0.9	−0.5	−4.8	−7.7	6.3	−0.4	−4.8	2.1	1.0	2.2	−0.1	−1.2	0.7	−0.2
Stutz Motor, 1920	0.5	−0.7	0.3	−0.3	−2.5	−2.4	−3.6	1.3	−1.8	0.3	1.5	−0.8	−1.7	−1.7	0.4	0.5	0.3	0.1	−0.3	−0.8	1.4
Piggly Wiggly, 1923	−0.5	−0.2	−0.6	0.4	0.5	0.5	−0.5	−0.8	0.9	0.4	0.0	−0.1	−0.1	−1.1	−0.7	−0.9	0.7	0.4	−0.7	0.0	−1.2
RCA, 1928	0.4	0.0	−0.1	0.5	1.2	0.9	−1.0	0.4	1.5	−0.5	1.5	−0.5	−0.6	0.9	0.9	−0.3	−0.2	0.8	0.8	−0.1	0.9
Mean	**−0.1**	**−0.4**	**0.2**	**0.8**	**0.5**	**−0.3**	**−0.5**	**0.3**	**0.1**	**0.8**	**−0.1**	**0.4**	**−0.9**	**−0.7**	**0.4**	**0.0**	**0.6**	**0.1**	**−0.1**	**−0.6**	**0.2**
St. Dev.	**1.3**	**1.3**	**1.4**	**1.2**	**1.3**	**1.1**	**1.3**	**1.0**	**1.0**	**2.5**	**2.8**	**2.3**	**1.8**	**1.6**	**0.9**	**0.7**	**0.7**	**0.6**	**1.3**	**2.1**	**0.8**
Failed Corners																					
Erie, 03 – 1868	0.7	0.5	−0.2	−0.9	1.0	0.5	−0.1	0.1	2.9	−0.2	−4.1	−0.3	0.4	0.2	−0.5	−1.5	−0.1	0.7	0.6	0.0	0.0
Gold, 1869	0.2	−0.2	−0.4	−0.6	−1.4	0.7	0.3	−0.8	−2.5	0.3	0.4	−1.0	−3.8	−4.5	1.7	1.2	2.2	0.1	0.2	−0.2	−0.1
Erie, 1872	−0.5	0.1	0.0	−0.1	0.4	−0.6	0.0	0.5	0.5	−0.3	−1.7	0.2	0.1	0.5	−0.1	−0.1	−0.2	0.0	−0.3	0.8	−0.2
Silver “corner”, 1980	0.4	2.1	0.1	1.0	−0.1	0.6	0.6	−0.4	−0.2	0.4	0.6	−0.8	1.3	0.3	−0.4	0.3	−0.5	0.9	−0.7	0.6	−0.7
Mean	**0.2**	**0.6**	**−0.1**	**−0.1**	**0.0**	**0.3**	**0.2**	**−0.1**	**0.2**	**0.0**	**−1.2**	**−0.5**	**−0.5**	**−0.9**	**0.2**	**0.0**	**0.3**	**0.4**	**0.0**	**0.3**	**−0.2**
St. Dev.	**0.5**	**1.0**	**0.2**	**0.8**	**1.0**	**0.6**	**0.3**	**0.6**	**2.3**	**0.4**	**2.2**	**0.5**	**2.3**	**2.4**	**1.0**	**1.1**	**1.3**	**0.4**	**0.6**	**0.5**	**0.3**

ship in the corner period. We use the theoretical implications of Llorente et al. (2002), running the following regression:

$$R_{i,t+1} = C_0 + C_1 R_{i,t} + C_2 R_{i,t} V_{i,t} + C_3 R_{i,t} V_{i,t} D_i + \varepsilon_{i,t+1}, \tag{28}$$

where i indexes the corresponding company/security from our sample, R_i is the continuously compounded return based on the closing price, V_i is the natural logarithm of the total number of shares traded, and D_i is a dummy variable with value 1 in the $[t-10, t]$ period around the corner date, t.[27] In their formulation, Llorente et al. (2002) ascertain that conditional on high trading volume, positive C_2 coefficients are evidence of private information trading in the market. To adapt their framework to our analysis we test whether the C_2 coefficient is increased in the $[t-10, t]$ period. Thus, we are interested in testing whether the coefficient (C_3) of the interaction term, $R_{i,t} V_{i,t} D_i$, has a positive sign. If indeed private information trading was prevalent in the first corner period, then we would expect that the C_3 coefficient would be positive and significant.[28] We explore the analysis of our hypothesis for each of the twelve corner stocks and one corner commodity (silver futures contracts). We find statistically weak evidence of informed trading in the period $[t-10, t]$: twelve of the thirteen C_3 coefficients are positive; however only four of them are significant. Informed trading around corner dates appears stronger for successful corners (higher average C_3 and R^2). In unreported results we find that these conclusions are robust to different period lengths, $[t-5, t]$, and $[t-20, t]$. The results from Table VI are also consistent with the autocorrelation results presented in Table II.

We are mindful of the limitations of the above test of private information trading: even though individual C_3 coefficients are for the most part positive, they are generally insignificant. Perhaps this is due to the small sample we use in individual regressions as can be seen in Table VI. To mitigate this constraint, we estimate a pooled regression, where we have restricted only the coefficient C_3 to be the same for all stocks/commodities while allowing the other coefficients to vary (introducing fixed effects for C_0, C_1, and C_2), an approach which allows us to test whether the imposed constraint on C_3 is a true one.

$$R_{i,t+1} = C_{i,0} + C_{i,1} R_{i,t} + C_{i,2} R_{i,t} V_{i,t} + C_3 R_{i,t} V_{i,t} D_i + \varepsilon_{i,t+1}, \forall i, t. \tag{29}$$

[27] In their work, Llorente et al. (2002) use a measure of turnover, defined as the logarithm of the total number of shares traded scaled by the total number of shares outstanding. They further detrend this variable with a 200-days moving average. Given the data source limitations we faced, we could not replicate their proxy for trading volume – the total number of shares outstanding is not available for the stocks in our sample, and the data is available only for 60–100 days around the market corner. We note though that our proxy – logarithm of the total number of shares traded has the same time-series behavior if we assume that there is no change in the total number of shares outstanding within the corner period. Moreover, Llorente et al. (2002) show that the empirical implications of their theoretical result hold for total trading volume. Thus we use the logarithm of total trading volume.

[28] Here, price manipulation can be viewed as a special case of private information trading in which the manipulator controls a large float of shares and determines the timing of the corner.

Table VI. Test of dynamic return-trading volume relationship (Llorente et al. (2002))

We present the results of the regression $R_{i,t+1} = C_0 + C_1 R_{i,t} + C_2 R_{i,t} V_{i,t} + C_3 R_{i,t} V_{i,t} D_i + \varepsilon_{i,t_1}$, where i indexes the corresponding cornered security from our sample, R_i is the continuously compounded return based on the close price, V_i is the natural logarithm of the total number of shares traded, and D_i is a dummy variable with value 1 in the $[t-10, t]$ period around the corner date. We also report coefficients from the pooled regression, where we have restricted coefficient C_3 to be the same for all stocks/securities while allowing the other coefficients to vary (fixed effects for C_0, C_1, and C_2), $R_{i,t+1} = C_{i,0} + C_{i,1} R_{i,t} + C_{i,2} R_{i,t} V_{i,t} + C_3 R_{i,t} V_{i,t} D_i + \varepsilon_{i,t+1}, \forall i, t$. * indicates 10% level significance while ** indicates 5% level significance.

Company	Obs.	C_0	C_1	C_2	C_3	t-stat (C0)	t-stat (C1)	t-stat (C2)	t-stat (C3)	R^2 (%)
Successful Corners										
Harlem, 1863	71	0.00	0.51	−0.06	0.03	0.42	0.32	−0.36	0.60	1.2
Harlem, 1864	76	0.01	−1.81	0.18	0.09	2.03	−2.13	1.91	1.31	8.4
Prairie du Chien	74	0.02	−0.61	0.10	−0.02	1.28	−0.61	0.62	−0.48	0.6
Michigan Southern	76	0.00	−1.78	0.16	0.04	0.85	−0.55	0.48	1.09	4.6
Erie, 11 – 1868	76	0.00	0.87	−0.08	0.13**	−0.32	0.89	−0.85	4.46	28.3
Northwestern	74	0.00	−0.76	0.12	0.04	−0.35	−0.46	0.63	1.62	23.8
Northern Pacific	76	0.01	5.22	−0.67	0.40**	1.52	7.38	−8.15	11.20	69.9
Stutz Motor	62	0.01	−0.39	0.08	0.01	2.06	−0.37	0.57	0.38	11.5
Piggly Wiggly	65	0.01	2.17	−0.30	0.02	1.62	1.44	−1.58	0.51	6.9
RCA	76	0.00	−2.23	0.18	0.06**	0.49	−0.98	0.94	2.81	29.9
Mean	**73**	**0.01**	**0.12**	**−0.03**	**0.08**					**18.5**
Pooled Regression (successful corners)	**726**				**0.09****				**7.07**	**19.0**
Failed Corners										
Erie, 03 – 1868	73	0.00	4.56	−0.43	0.00	−0.47	1.65	−1.56	−0.03	7.3
Gold, 1869										
Erie, 1872	73	0.00	1.26	−0.13	−0.02	−0.37	0.58	−0.64	−0.39	2.5
Silver "Corner", 1980	70	0.01	−1.38	0.16	0.06	1.28	−0.85	0.85	1.12	3.5
Mean	**72**	**0.00**	**1.48**	**−0.14**	**0.01**					
Pooled Regression (failed corners)	**216**				**0.01**				**0.59**	**5.1**
Overall Pooled Regression	**942**				**0.08****				**7.67**	**18.2**

The estimates of C_3 from the pooled regression are reported in Table VI. Both successful and failed corners exhibit positive, C_3 coefficients, however only the coefficient for successful corners is statistically significant. When we pool all stocks/commodities and perform the regression, the result is again a positive and highly statistically significant C_3 coefficient of 0.08 with a t-statistic of 7.67. We interpret this as supporting our hypothesis of private information trading prior to the market corner developed in the theoretical model of Section 2.

A final implication of our empirical model is that corners only occur when there is bad news. We consider this implication of the model by reviewing the direct evidence about the news around successful corners. There is limited support for this hypothesis. Four out of the ten successful corners were brought upon the reported rumors/announcements of bad news associated with the cornered stock. In the case of the first Harlem corner in 1863, the corner took place upon the repeal of the ordinance allowing the construction of the streetcar system in New York City. Similarly, the second Harlem corner in 1864 was an outcome of the defeat of the bill authorizing the extension of the Harlem railroad system. There is also historical evidence that the Stutz Motor Company corner was due in part to the reported rumors of a bear raid in the stock. Estimates by Oldfield (2006) provide evidence that before such rumors become reportedly present in the market, shares of the Stutz Motor company were fairly priced. He further notes that the price increase in Stutz motor company's shares upon the emergence of the rumored bear raid were amid a general decline of the Dow Jones automotive index in 1920. Finally, in the case of the Piggly-Wiggly corner, the event took place after the president of Piggly-Wiggly cancelled his plans to issue new stock. Unfortunately, we could not uncover enough information for the other six successful corners to indicate whether there was bad news or not.

5. Concluding Remarks

This paper has developed a rational expectations theory of corners. It was shown that corners can be the result of rational behavior by all agents. Unfortunately, corners reduce the efficiency of the market in the sense that prices do not reflect values well. The possibility of a corner means that arbitrageurs will only be willing to take a short position when the prospect of profits is high. The rest of the time they stay out of the market. In addition the paper investigates price and trading volume patterns around some well known stock market corners in US history. The analyses are based on a hand-collected new dataset of price and trading volume reported in the New York Times and Wall Street Journal from 1863–1980. We present strong evidence that large investors and corporate insiders possess market power that allows them to manipulate market price. Our results show that market corners as a result of manipulation tend to increase market volatility and could have an adverse price impact on other assets. We demonstrate that the presence of large investors makes it extremely risky for short sellers to arbitrage mispricing in the stock market. This creates severe limits to arbitrage in the stock market that tends to impede market efficiency. It can create a situation when there can be overpricing but arbitrageurs are unwilling to establish a short position because of manipulation risk (in addition to fundamental and noise trader risk). Therefore, regulators and exchanges need to be concerned about ensuring that corners do not take place since they are accompanied by severe price distortions.

Appendix A: Famous Market Corners In America's Financial History

1. The First Harlem Corner[29] (1863)

Allen and Gale (1992) describe the 1863 Harlem corner: "At the beginning of 1863, Commodore Cornelius Vanderbuilt bought stock in the Harlem Railway at around $8 to $9 a share. He took an interest in running the company and its stock price advanced to $50 per share. In April, 1863, the New York City Council passed an ordinance allowing the Harlem Railway to build a streetcar system the length of Broadway and, as a result, the stock price went to $75. Members of the council (and Daniel Drew, a director of the company) then conspired to sell the stock short, repeal the ordinance, and thus force the price down. However, Vanderbuilt discovered the plot and managed to buy the entire stock of the company in secret. When the members of the council tried to cover their short positions after the repeal of the ordinance, they discovered that none of the stock could be purchased. Vanderbuilt forced them to settle at $179 per share."

2. The Second Harlem Corner[30] (1864)

After the betrayal by the New York City Council, Vanderbilt decided to go to Albany to get his Harlem Railway extension directly from the New York State Legislature. Hoping for revenge, Drew conspired with the unwary state legislators to spread news about the likely passing of the legislation, push up the price, then proceed to sell the stock short, defeat the bill, and force the price down. The stock price dropped from $150 to $100 in two days. Vanderbilt was furious and bought more shares than were actually in existence. He forced the short sellers to settle at $285 and Drew again lost over half a million dollars.

3. The Prairie du Chien Corner[31] (1865)

On Nov. 6th, 1865, a bull pool led by William Marston, a well known stock market operator at the time was reported by the *New York Times* as having gained control of the entire outstanding 29,880 shares of Prairie du Chien Railroad Company as

[29] Chancellor (2000, chapter 6) and Allen and Gale (1992).
[30] Clews (1888, chapter 34) and Sobel (1988).
[31] See *New York Times*, 11/07/1865, Financial Affairs section.

well as a similar amount of short interests. The pool called for a settlement that morning, which led to "… one of the sharpest and beyond all precedent the most sudden corner known to the forty years' history of the New York Stock Exchange".

4. The Michigan Southern Corner[32] (1866)

According to the New York Times of April 6th, 1866, "the Street were enlivened today (referring to April 5th) by one of those extraordinary special movements in the Railway market which will periodically occur on the Bull side of the speculation, as it more frequently occurs on the Bear side of the speculation. … The cash stock was at no time made scarce for delivery up to yesterday afternoon (April 4th). The case appeared to be different this morning, judging from the eagerness and excitement to buy at the early Board". The above source also points out that one of the manipulators has reportedly been a director of Michigan Southern: "two of the three prominent managers (in the cornering clique) are said to have been notorious bankrupts, whose paper is in every man's pocket book, and the third a prominent official of the road, whose speculations have been so flagrant that a bill has been introduced into the Legislature to check them". One of the famous manipulators on Wall Street of the time – Daniel Drew, was reportedly one of the short-sellers who participated in this market corner. While we could not clearly identify the manipulators, the complaint by Daniel Drew, filed with the Supreme court seeking injunction against the firm of Scott, Capron, & Co (lenders of the Michigan Southern stock to Daniel Drew), noted that "the plaintiff (Drew) is informed and believes that the defendants (Scott, Capron & Co) are a party to the said fraud and conspiracy, and desire and intend thereby to defraud and injure the plaintiff".

5. The Failed Erie Corner[33] (March 1868)

In 1868, Vanderbilt set out to wrestle control of the Erie Railroad from Daniel Drew and Jay Gould. He was confident due to his victories in the Harlem battles and he had as his allies a group of Boston capitalists who had a large block of Erie stocks. So he proceeded to buy control of the company while Drew and Gould were selling. He poured millions into the purchase of the stock and had apparently bought more stocks than were in existence. So it looked as if the short sellers were cornered. However, Drew was well prepared this time. As a director of the company, he surprised Vanderbilt by converting a large hidden issue of convertible bonds into common stocks and flooded the market with these new shares. Vanderbilt's corner was broken after he had sunk in seven million dollars for Erie stock.

[32] Chancellor (2000, chapter 6).
[33] Chancellor (2000, chapter 6).

6. The Erie Corner[34] (November 1868)

In late 1868, Drew and Gould were involved in a bear raid on the market by selling Erie and other stocks short. Then they tried to force the interest rates up and a general market decline by a large withdrawal of funds from New York banks. Agitated by Drew's wavering during the operation, Gould suddenly switched his strategy from bear raid to bull run. Unaware of Gould's switch, Drew kept on selling Erie short. The price dropped from $50 to $40 in October and went further down to $35 on November 13. But Gould by then had bought all the floating shares of Erie. On November 16, the price suddenly jumped to $55 and Drew was cornered with 70,000 shares short.

7. The Failed Gold Corner[35] (1869)

In 1868, the whole floating supply of gold was about $20 million and the government held about $75 million in reserve. Jay Gould thought that this whole supply could be cornered and thus selling it at an inflated price. He conspired with Abel Corbin, the brother-in-law of President Grant, to influence government policy on gold. On numerous occasions, he lobbied Grant and government officials on the benefits of high gold prices. For a moment, it appeared that Grant was quite convinced. Gould proceeded to accumulate a $50 million position in gold and the price had risen from 130 to 137. To increase his chance of success, Gould then launched an aggressive lobbying of government officials who began to suspect his speculative motives. Sensing the government might intervene to break his corner, he secretly sold his position while urging his friends to buy at any price. On October 4, the feverish purchase by Gould's friends had pushed the gold price from 140 to 160, but government selling later during the day quickly broke the squeeze and brought the price back to $140. This day had gone down in history as another Black Friday, since hundreds of firms on Wall Street were ruined by the huge price swing.

8. The Failed Erie Corner[36] (1872)

In the summer of 1872, Jay Gould asked Daniel Drew and Henry Smith to join him for a bear raid on Erie stocks. They conspired to depress the stocks by suddenly withdrawing large sums of money from New York banks, which created a small liquidity crisis due to the lack of lenders of last resort at the time. But Drew turned bullish after their initial success. So he reversed his trades and proceeded to build a large position without notifying Gould and Smith. On September 17, he cornered the market by calling for a settlement. But Gould was able to deliver the stocks. However, the corner had a large impact on the prices of all stocks.

34 Sharp (1989).
35 Chancellor (2000, chapter 6).
36 Chancellor (2000, chapter 6).

9. The Northwestern Corner[37] (1872)

In November 1872, Jay Gould tricked Daniel Drew and Henry Smith into joining him for another bear raid by selling Northwestern stock short. Not suspecting Gould's intention, they kept selling the stock short while Gould at the same time was building a huge position. The rising price made Smith suspicious and he got a warrant for Gould's arrest on charges of looting the Erie treasury. Gould wriggled out of the charges and decided to ruin Drew and Smith by cornering the market on Northwestern. The price soared from $80 to $230 in a few days and they were asked to settle at that price. The corner had a serious impact on the prices of all stocks.[38]

10. The Northern Pacific Corner[39] (1901)

In spring 1901, J.P. Morgan and a group of investors led by Edward Harriman fought for the control of the Northern Pacific Railroad, which could lead to gaining control of railroad traffic to the Pacific coast. Harriman started by acquiring $40 million from the common stock, running just short of 40,000 shares of gaining control. Alarmed by the scheme, J.P. Morgan went out to acquire the remaining stocks and his purchase sent prices soaring from $114 to $147 in 5 days. Noticing the unusual increase in the price, a group of short sellers built a large short interest volume in the stock. On May 9th short sellers realized that they were caught in an unintended corner, and the price went from $170 to a record level of $1000 during the day. The market for other stocks plummeted since short sellers were hard press to cover their positions by selling their other assets.[40] The volume traded was 3,336,000 for the day, a record not broken until 1925. Morgan and Harriman agreed to settle with the short sellers at $150 the next day.

11. The Stutz Motor Company of America, Inc. Corner[41] (1920)

Allan Ryan, known in the early twentieth century as a speculator good at the art of squeezing short sellers, had bought a controlling interest in the Stutz Motor Company of America, Inc. At the beginning of 1920, its price had risen steadily from $100 to $134. Ryan was told that short sellers had taken action thinking that the price had risen too high. Among the short sellers were some prominent members of the stock exchange. To counter the bears, Ryan borrowed substantial amounts to buy additional shares. At first, despite Ryan's heavy purchase, the

[37] Chancellor (2000, chapter 6).
[38] See *New York Times*, November 26th, 1872 and also Chancellor (2000, p. 171).
[39] Thomas (1989), Sobel (1988) and Wycoff (1968).
[40] Kyle and Xiong (2001) develop a model that captures the contagion effect.
[41] Oldfield (2006) and Brooks (1969).

price went down, since the short-selling pressure was considerable. But then the price increased in late March, reaching $391. Towards the end of March, short sellers were selling stock that had to be borrowed from Ryan, since he had almost all floating shares. On March 31st, the Governing Committee of NYSE announced that it had decided to suspend all dealings in Stutz Motor stock for an indefinite period due to irregular price movements. On April 20th, the Protective Committee of NYSE announced that it was ready to accept impartial mediation on a negotiated-settlement price that led to a settlement at the price of $550. Shortly after this fiasco, the NYSE quietly amended its constitution by allowing the Governing Committee to postpone the time for deliveries on contracts for the purpose of preventing market corners.

12. The Piggly-Wiggly Corner[42] (1923)

Piggly-Wiggly was a grocery chain in the Midwest. Clarence Saunders, the president of Piggly-Wiggly, wished to make a seasoned equity offering. To raise the price of the stock, he hired a well known stock manipulator, Jesse Livermore, to push up the stock price. The rising price attracted substantial short interest, which eventually led to a market squeeze in mid-March. Given his large position, Clarence Saunders thought that he could make more money by canceling his previous plan to issue more stocks and thus make the bears pay even more. On March 23, the price soared 50 points in a single day. However, the governors of the Big Board decided to delist Piggly-Wiggly the next day, and let the bears buy the stock at a nominal price.

13. The Radio Corporation of America Corner[43] (1928)

In 1927, William Durant, an automobile legend turned speculator, took an interest in a young company, Radio Corporation of America. He noted that the bulk of the shares issued by RCA were held by RCA itself, General Electric, Westinghouse, and several other big corporations, and these shares were not traded. In addition, there was much hype on the market for RCA, since its radio transmission was considered a revolution in communications technology at the time. Thus Durant started a pool to accumulate the RCA stock. As a result of the feverish purchases by the Durant group, they soon bought almost all floating shares as well as shares sold short. Their trading generated daily turnover of above 500,000 shares, while officially there were only 400,000 floating available. The pool forced the market into a technical corner in March 1928. The corner was unintentional because a large part of the shares was not under the control of the manipulators and they never called for a settlement. From March 12th, the bears started struggling to settle their accounts and the price rose more than $61 in four days.

[42] Brooks (1969) and Markham (2001).

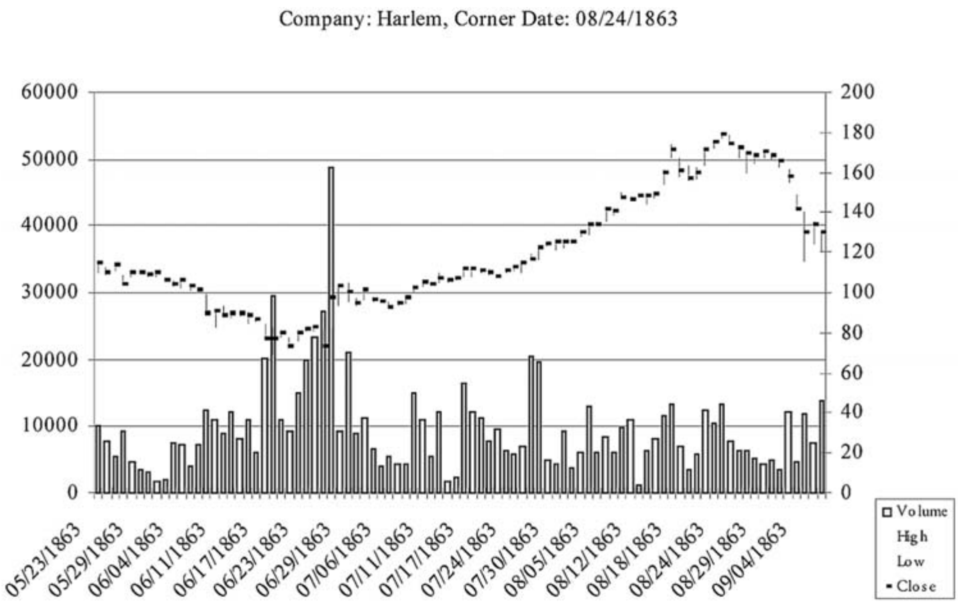
[43] Thomas (1989).

14. The Silver Corner[44] (1980)

In 1974, Bunker and Herbert Hunt, children of the Texas oil magnate H.L. Hunt, started investing in silver as a hedge against inflation. As they controlled more and more of the world's silver, the price shot up from $11 an ounce to more than $50. To alleviate speculation on the New York Metals Market, The New York Commodities Exchange (COMEX) changed its trading rule by placing a 500 contract limit that traders may hold. Afterwards, as silver prices slid, the Hunt brothers failed to meet huge margin calls on their futures contracts, sparking a panic on commodity and futures exchanges and a 50% plunge of prices from $21.62 to $10.80 on March 27, 1980. Later, former Federal Reserve Board chairman Paul Volcker estimated that "at one point" that winter Hunt-related interests may have controlled two-thirds of the 170 million ounces of US silver stocks. He also reported to Congress that the Hunt brothers were seeking more than $1 billion to help them restructure their silver trading debts in April 1980.

Appendix B: Price and Volume Chart of Well Known Market Corners

Figure 1A.



44 Dow Jones New Service, 4/30/1980, "Volcker Says Hunts Seeking Over $1 Billion For Silver Debts" and "Volcker Discloses Hunt Silver Debts".

Figure 2A.

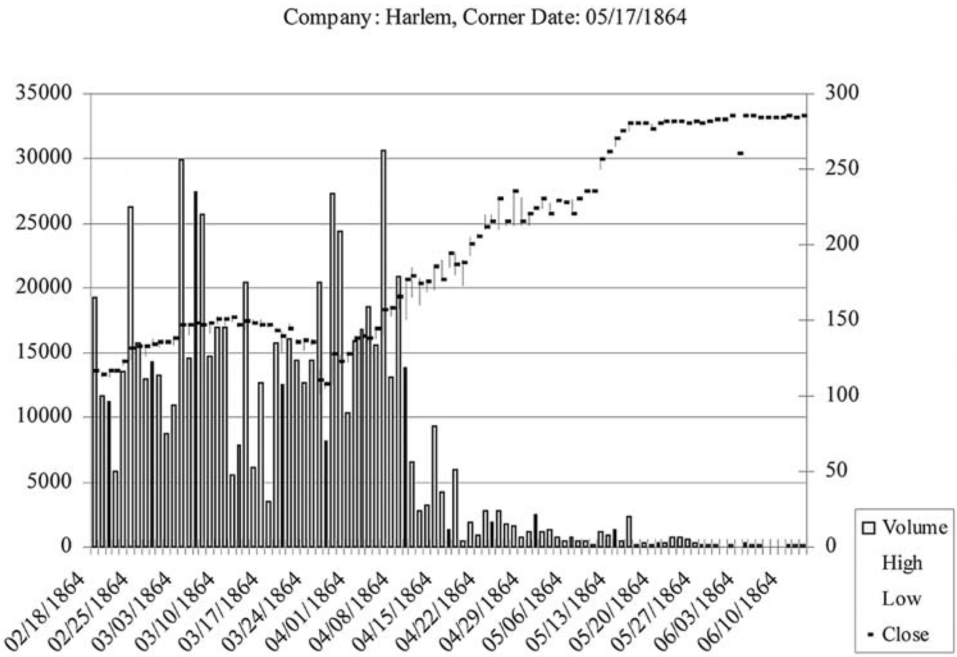


Figure 3A.

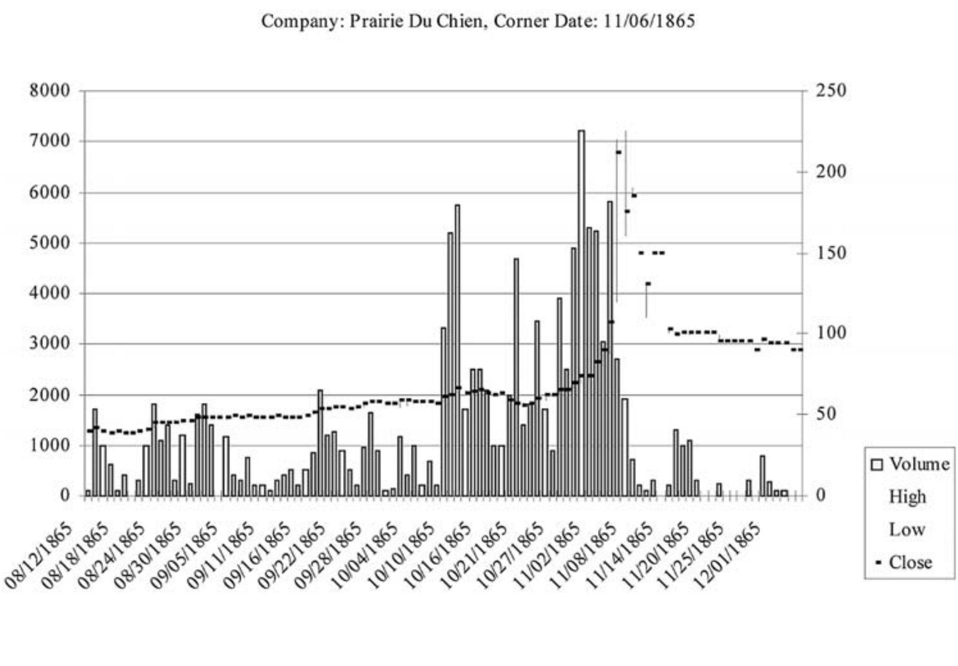


Figure 4A.

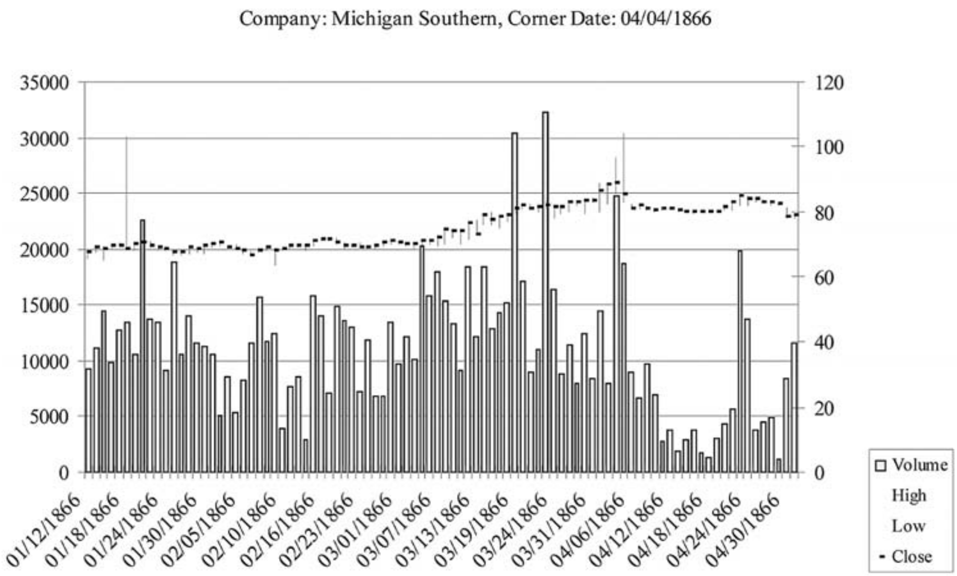


Figure 5A.

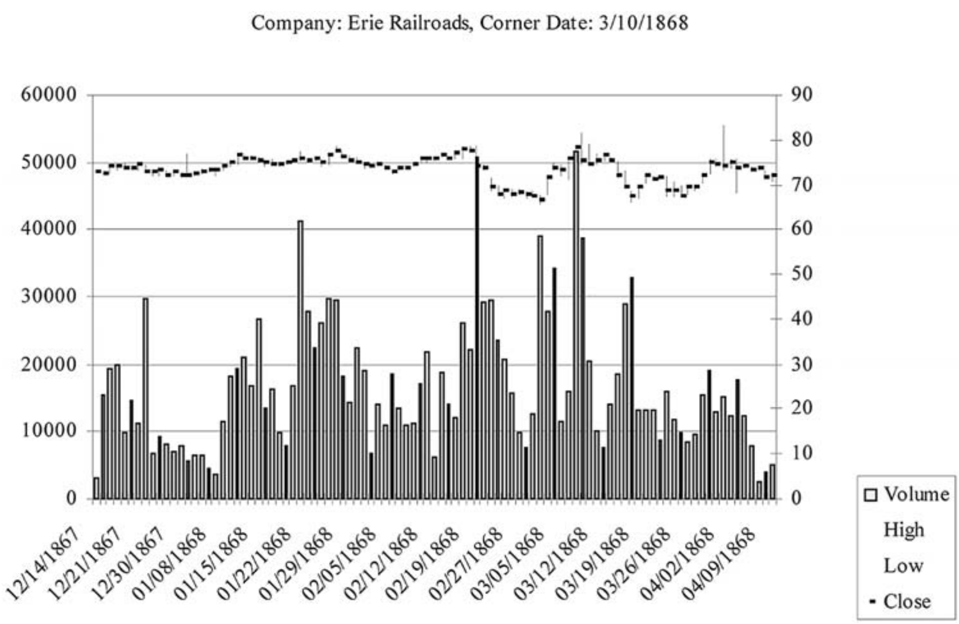


Figure 6A.

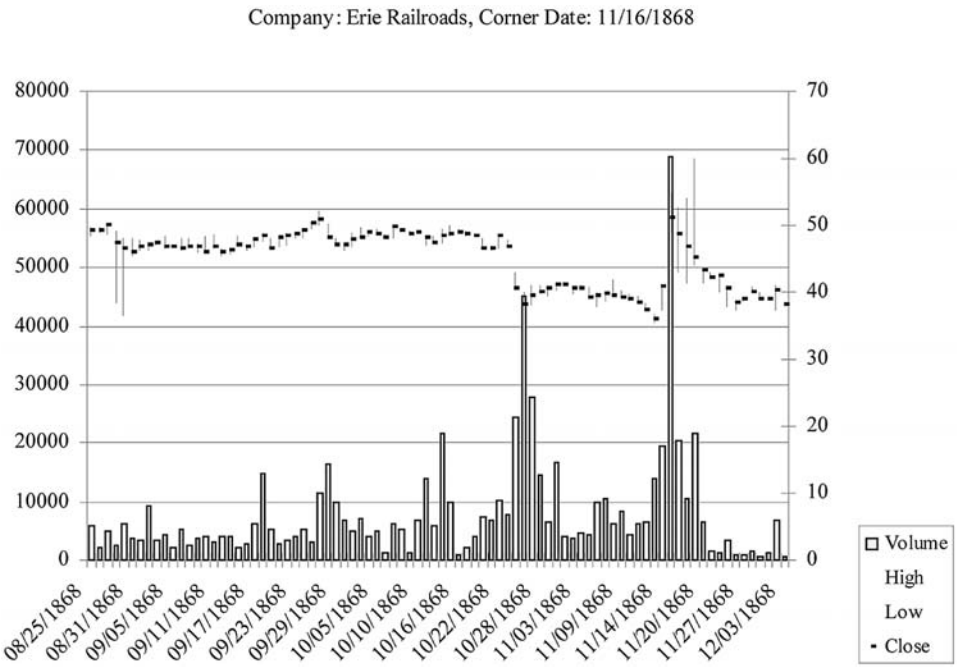


Figure 7A.

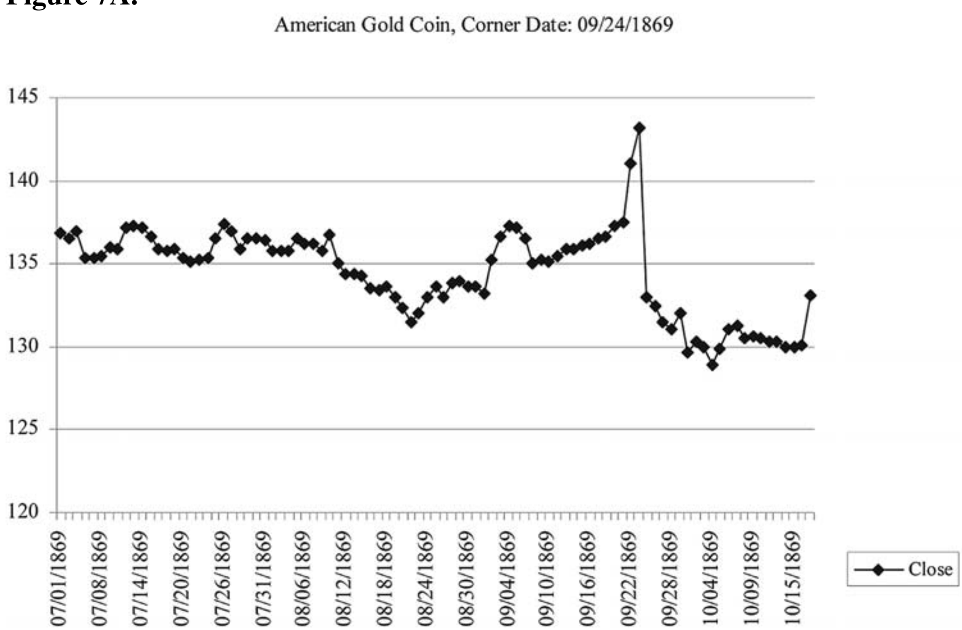


Figure 8A.

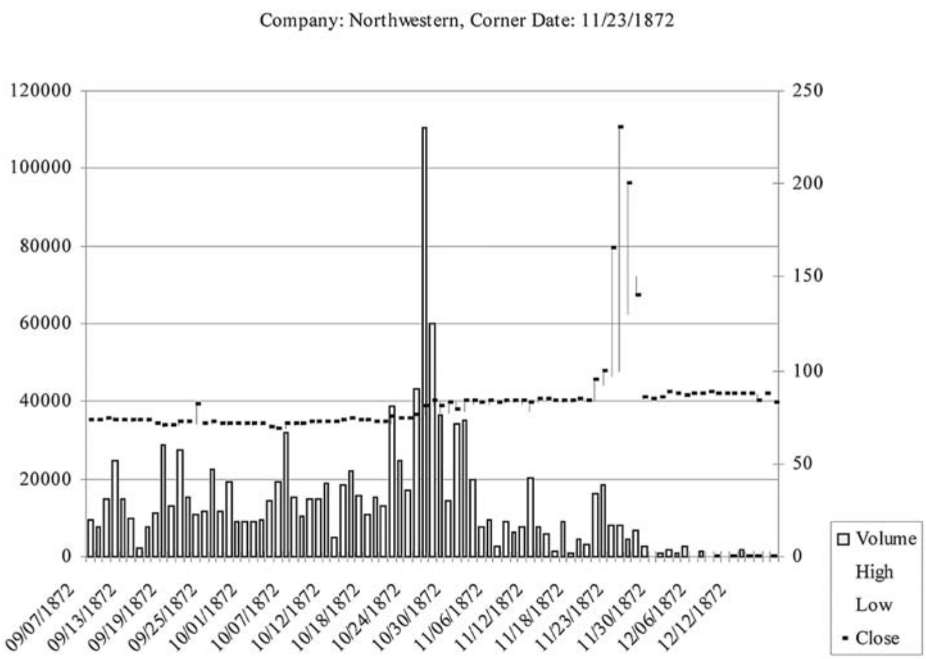


Figure 9A.

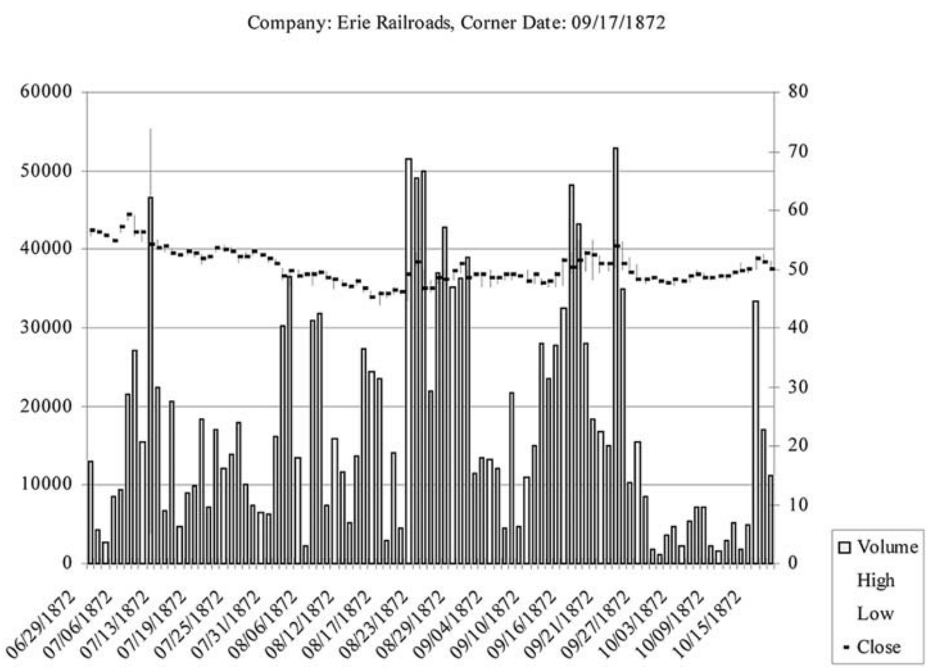


Figure 10A.

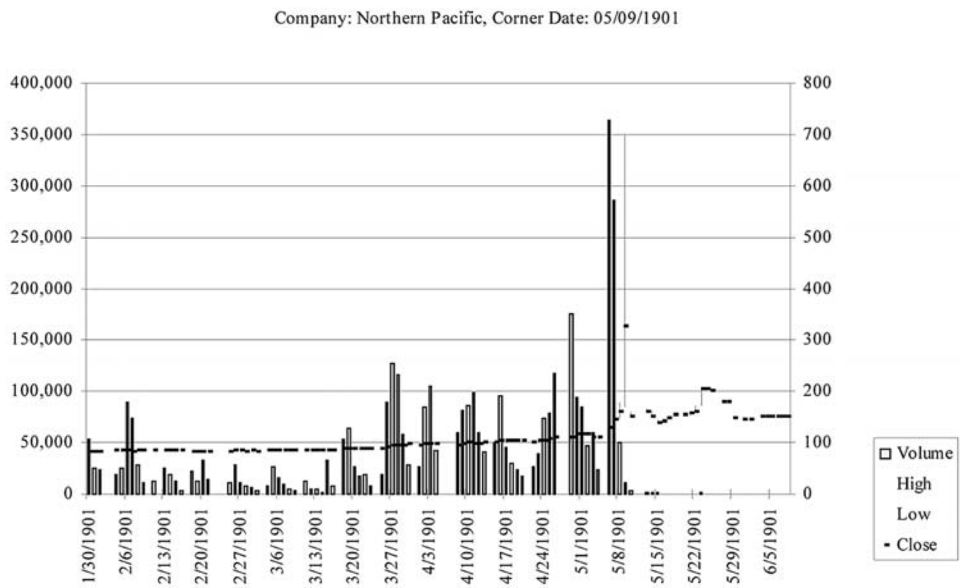


Figure 11A.

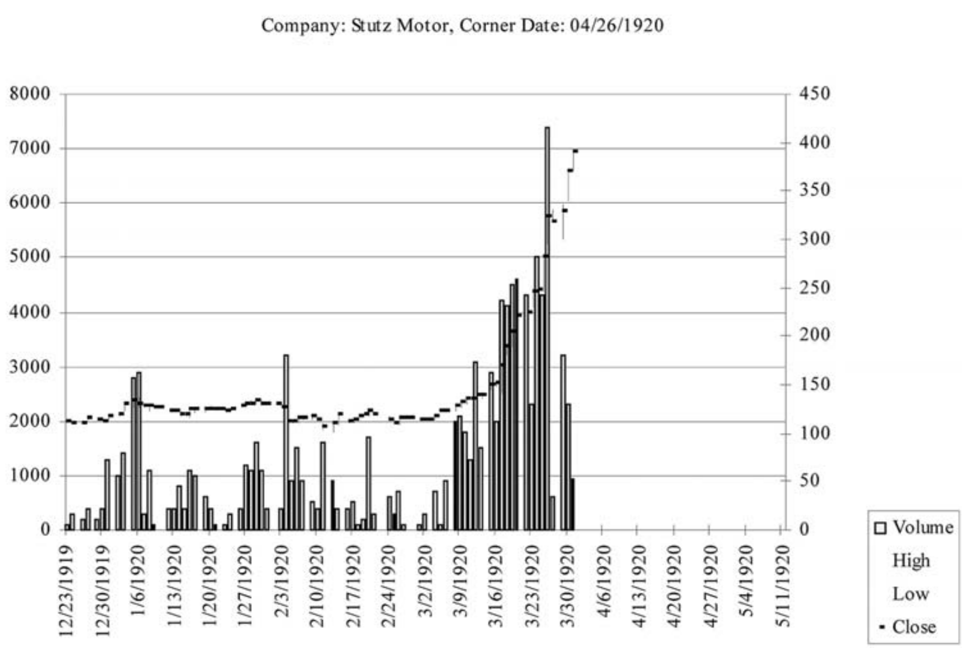


Figure 12A.

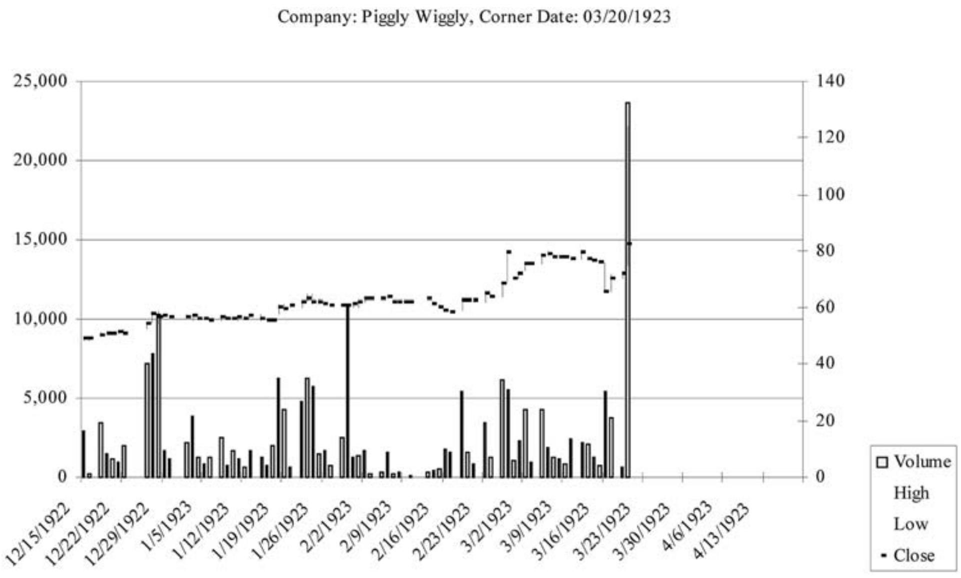


Figure 13A.

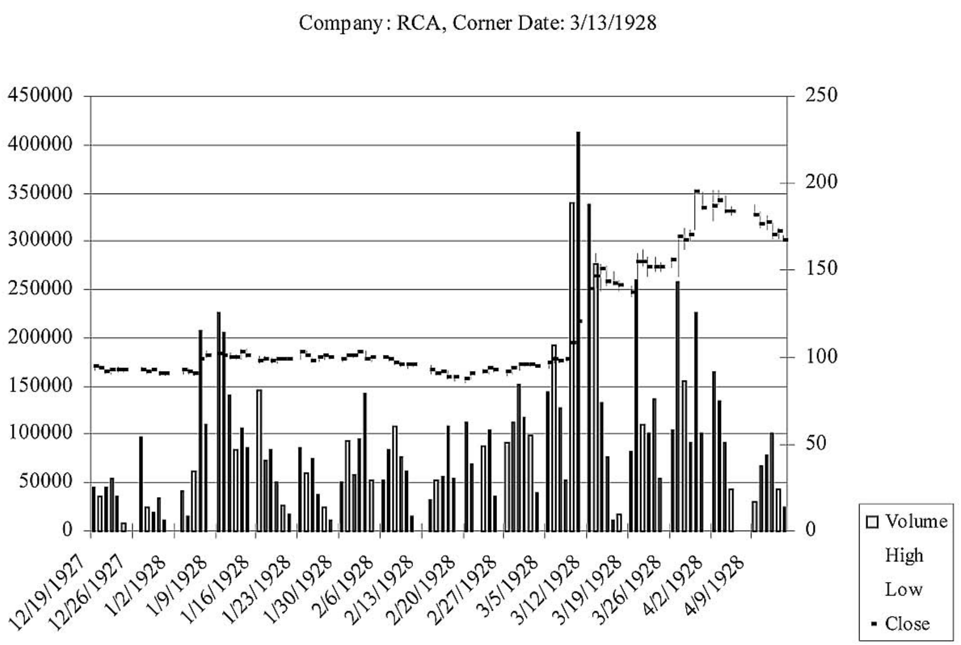
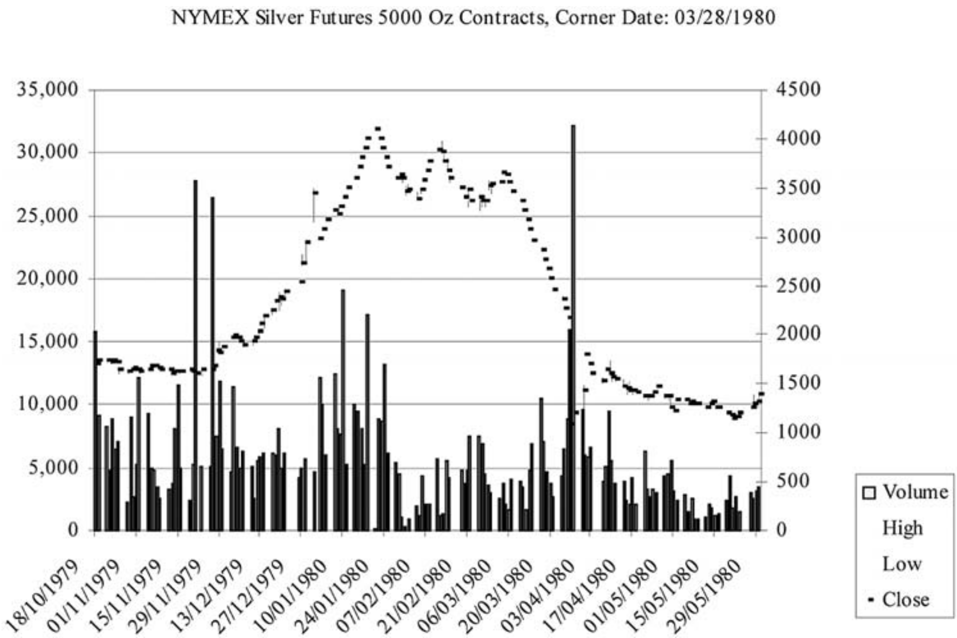


Figure 14A.



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