In order for plaintiffs to certify a class in securities fraud class action litigation, they must demonstrate that class members relied on the allegedly fraudulent information. For cases involving publicly traded securities, one way plaintiffs can demonstrate reliance is to show that the securities at issue traded in an efficient market. Prices of securities that trade in an efficient market reflect all publicly available information and quickly respond to new information, and can thus be relied on to reflect relevant information about the security, including any information that was allegedly misrepresented. During the class certification stage of the litigation, plaintiffs may argue that the efficiency of the prices of a security can be used to provide an assumption of reliance for purchasers of the security. During the merits stage, efficient prices may be used to estimate alleged damages, as price movements form the basis for measuring the effect of particular events.

In securities litigation, the efficiency of the market for a security is routinely evaluated based on various criteria starting with those listed by the court in Cammer v. Bloom, known as the Cammer factors. These factors were listed by the court as indications of whether a market is efficient. This paper focuses on one specific Cammer factor, the existence of market makers and arbitrageurs in the market. In particular, an important issue to be addressed is whether traders are able to complete short sale transactions and thus fully participate in the market. A short sale enables a trader to take a negative position in a security, and is a crucial mechanism by which negative information can be rapidly reflected in market prices, but may be hindered by various constraints. Therefore, as part of Cammer factor analyses, indicators of constraints to short sales are valuable in evaluating claims of market efficiency.
A trader takes a negative, or short, position in a security by selling borrowed shares rather than owned shares. Borrowing shares requires finding a lender and negotiating a share loan, hurdles that can restrict trades from taking place. Consider, for example, a scenario in which a trader has a negative opinion of a stock he doesn’t own. One way he may act on his beliefs is to short the stock by finding a lender, borrowing shares from him (possibly at a cost), and selling those shares in the open market, hoping to profit by buying shares back after the stock price has fallen. By short selling the stock, the trader’s negative information becomes better reflected in market prices. Because this type of transaction is more complex than a typical share sale, complications may result in negative information not being quickly reflected in market prices. In turn, this may affect market efficiency. Consequentially, short sale constraints must be evaluated as part of an analysis of market efficiency.

**Market Efficiency in Securities Litigation**

In its seminal decision in *Basic v. Levinson*, the Supreme Court ruled that plaintiffs in 10b-5 litigation may claim a rebuttable presumption of reliance on the market price of securities traded on a “developed securities market, [where] the price of a company’s stock is determined by the available material information regarding the company and its business.” Investor reliance on market prices hinges on the definition of the Efficient Market Hypothesis, which states that prices in an efficient market reflect all publicly available information and quickly respond to new information. Thus, any alleged misstatements would also be reflected in the stock price. Plaintiffs, therefore, may claim reliance on alleged fraud through reliance on the “integrity of the market price” rather than demonstrating individual reliance on any misrepresentation.

Although the *Basic v. Levinson* court did not mandate how to test for market efficiency, the later case of *Cammer v. Bloom* identified five factors that suggest a security traded in an efficient market:

1. The existence of an actively traded market for the security, as evidenced by a large weekly volume of trade,

2. That a significant number of securities analysts followed and reported on the security,

3. The existence of market makers and arbitrageurs who reacted swiftly to new information,

4. The eligibility of the underlying firm to file a SEC Form S-3 registration statement, and

5. Evidence of a cause and effect relationship between unexpected corporate events or financial releases and the security price.

Analyses of these factors form the basis for market efficiency analysis in securities class actions, and may be augmented with factors related to specific market attributes.
The focus of this paper is on the third Cammer factor, the existence of market makers and arbitrageurs, and how their effectiveness may be affected by short sale constraints. Market makers facilitate trading and provide liquidity, while arbitrageurs swiftly transact in mispriced securities to ensure that prices always reflect available information. The Cammer court justified the importance of these participants in an efficient market since they “ensure completion of the market mechanism” by “react[ing] swiftly to company news and reported financial results by buying or selling stock and driving it to a changed price level.” The value of these participants hinges on their ability to quickly buy or sell shares so that market prices always reflect all publicly available information. Arbitrageurs frequently react to negative information by shorting stock, while market makers frequently facilitate trades by short selling. If short selling is expensive or impossible, then completion of the market mechanism is impeded, which negatively affects market efficiency.

**Short Sale Constraints and the Polymedica Court**

While affirming the Cammer factors as suggestive of market efficiency, the Polymedica court took a step toward defining market efficiency to be the “information efficiency” of stock prices. The court concluded that an “efficient market is one in which the market price of the stock fully reflects all publicly available information,” and defined “fully reflects” as instances when the “market price responds so quickly to new information that ordinary investors cannot make trading profits on the basis of such information.”

In discussing the term “fully reflects,” the Polymedica court emphasized that the speed of market adjustment to new information “depends on professional investors’ ability to complete arbitrage transactions.” Arbitrage was interpreted as the purchase or sale of a security until the market price reflects the new information or, as Polymedica’s expert Dr. Frederick Dunbar put it, arbitrage is “the mechanism by which information becomes impounded in the stock price.”

Arbitrage promotes market efficiency through timely transactions by professional investors. If such investors trade on positive information, then their share purchases raise prices to the efficient level. Conversely, if such information is negative then professional investors who do not own shares must short-sell to lower prices to the efficient level. If professional investors are unable to quickly transact on their information, then market prices will not respond timely to new information or reflect all public information. In such a situation a stock is not efficiently priced.

The Polymedica court specifically highlighted the importance of short selling by arbitrageurs in an efficient market. It found that constraints on short selling could prevent a security’s price from reflecting its informationally efficient value. Consequently, short sale constraints can slow the dissemination of information into the market which, by impeding quick price responses to new information, violates a key tenet of market efficiency.
Market Efficiency in Securities Markets

The market price of a security is the equilibrium value arrived at by market participants. Traders, using available information, buy and sell shares until equilibrium is reached. It is through this market mechanism that information is aggregated and reflected in a single price. Since market prices are a product of the information and beliefs of participating traders, the exclusion of classes of traders or types of trades systematically reduces the amount of information reflected in equilibrium prices.

According to the semi-strong version of the Efficient Market Hypothesis, efficient market prices reflect all publicly available information and quickly respond to new information, which ultimately depends on arbitrageurs reacting swiftly to new information. Arbitrageurs are motivated by profits generated by transacting in mispriced securities, which also provides them with an incentive to seek out pertinent new, and sometimes costly, information. It is a consequence of such research and trading that market prices are driven toward efficiency.

If such participants with unique relevant information do not trade, then the information they possess will not be reflected in market prices. An example of the importance of arbitrageur participation is the divergent market prices of Chinese domestic class A shares versus Chinese foreign class B shares in the 1990s. Despite both classes of shares having the same underlying rights and claims, researchers found that foreign class B traded at an average discount of about 60% to the domestic class A share prices. The researchers concluded that the main reason for this discrepancy was that domestic investors had more information about the local firms, but due to market segmentation could not participate in the market for foreign class B shares. While prices of each security reflected the information and beliefs of each market’s participants, the exclusion of arbitrageurs from the foreign class B market resulted in mispricing.

Short Selling and Market Efficiency

Just as the exclusion of domestic traders from the market for Chinese foreign class B shares resulted in mispricing, so can the exclusion of short sellers from the market for a security. For instance, in an efficient market, a short seller with solid information that a stock trading at $10 was actually worth only $9 could borrow shares and arbitrage the price down to the $9 level. In contrast, if there are constraints and it costs $1 to short sell the stock, then it would not be profitable to arbitrage the price to the efficient $9 value. The stock would thus not reflect all available information and be inefficiently priced.

Short selling is an important tool of arbitrageurs, and excluding short sellers or restricting their trades can adversely affect how information is impounded into market prices. If the pool of traders able to transact in a security is limited to those who either own shares or have a positive opinion of the stock, then those who don’t own it and have a negative opinion are excluded from the market. This limits the pool of traders able to trade on negative information to those who already own the stock. Furthermore, it reduces the incentive for non-owners to seek out information that may negatively affect the stock price because they are unable to trade.
Short Sale Bans and Market Efficiency

There have been some real-world consequences of constraints on short sales. Constraints may be imposed by regulators, as most did in response to the 2007-2009 financial crisis. The Securities and Exchange Commission (SEC) was one such regulator, and on September 19, 2008 they issued an emergency order temporarily banning short sales of certain stocks, with the objective of “restoring equilibrium to [the] markets.” The SEC temporarily disallowed short selling in 799 stocks of financial institutions. The ban was intended to stem aggressive short selling of financial stocks; such firms were thought to be particularly susceptible to speculative attacks on their credibility as institutions and counterparties. Prior to the ban, it appeared that unfettered short selling had contributed to “sudden price declines in the securities of financial institutions unrelated to true price valuation.”

In a 2013 study, Alessandro Beber and Marco Pagano found that short sale bans like the one instituted by the SEC had negative effects on factors associated with market efficiency. A main conclusion was that the lack of short sales slowed price discovery, the process through which market prices respond to new information. They found that price discovery in response to negative information was particularly hampered, insofar as “a ban moderate[d] the trading activity of informed traders who have negative information… and thereby slow[ed] down price discovery.” According to the Cammer court, the specific role of market makers and arbitrageurs in an efficient market is to “react swiftly to company news and reported financial results by buying or selling stock and driving it to a changed price level.” The empirical finding that the inability to short sell moderates trading and slows price discovery is a symptom of the breakdown of the role of the arbitrageur in completing the market mechanism.

Concretely, the researchers conclude that short sale bans “prevent bad news from being rapidly impounded into stock prices.” Beyond the particular effects on arbitrageurs, such a finding runs contrary to generally accepted definition of an efficient market, also adopted by the Cammer and Basic courts, as “one which rapidly reflects new information in price.”

Beber and Pagano also found that banning short selling adversely affected market liquidity, which is the ability of the market to facilitate trading without greatly affecting prices. Although the Cammer court did not specifically identify liquidity as one of the five factors, it emphasizes that it is usually an important feature of a developed market.

Short Sale Constraints and Market Efficiency

Constraints on short selling may occur for reasons other than regulatory barriers. Given the mechanics of such a transaction, as discussed in the next section, stocks may become short-sale constrained simply because demand for loanable shares outstrips supply. An interesting example of such an effect was documented by Richard Thaler and Owen Lamont in a 2003 study. The researchers found that due to constraints on short sales, market prices violated a fundamental economic tenet: identical assets should have identical prices. Their motivating example was the spinoff of Palm from its parent company, 3Com.
On 2 March 2000, 3Com offered about 5% of its Palm subsidiary to the public via an initial public offering, and planned to issue the rest of the shares to 3Com shareholders by the end of the year. As part of the offering, holders of 3Com had the right to receive 1.525 shares of Palm stock for every share of 3Com that they owned. Given that conversion right, an investor could buy approximately 152 shares of Palm in two ways: either buy 152 shares of Palm in the open market or buy 100 shares of 3Com that, per the offering, included rights to about 152 shares of Palm. This simple conversion ratio implied that the price of 3Com should have been at least 1.525 times the price of Palm because each share of 3Com had rights to 1.525 shares of Palm. Immediately following the IPO, the closing market price of Palm was $95.06 per share, implying that, if arbitrageurs were able to trade, 3Com should have closed at least at $144.97.

Surprisingly, the price of 3Com actually fell on the IPO day to $81.81, much less than its implied value. If markets were operating smoothly, arbitrageurs could have paid $8,181.00 for 100 shares of 3Com and offset that position by receiving $14,449.12 from short selling 152 shares of Palm. Their net holdings of Palm would be about zero and they would have received $6,268.12 risk-free. The researchers pointed out that, despite the lucrative theoretical profits, such gains from this transaction were unlikely to be achievable because Palm was short-sale constrained. Due to the constraint, arbitrageurs could not engage in the above transaction. Short selling Palm stock was expensive or not possible, and the stock remained mispriced. This mispricing was not a short-term aberration; the researchers noted that it persisted for months on end despite widespread media coverage. Although this is an unusual situation, it brings up two important points regarding market efficiency:

1. Short sales are sometimes crucial to achieving efficient market prices, and
2. Short-sale constraints and related market inefficiency may persist for long periods of time.

**The Mechanics of a Short Sale**

The complex mechanics of short sale transactions are a primary factor behind the manifestation of related market inefficiencies. To provide intuition into how short sale constraints develop, and how to identify if a stock is constrained, it is helpful to understand the details of short sale transactions. A short sale is different than a typical stock sale. In a typical sale, a trader might sell shares from his account to a buyer at an agreed upon price, and some time afterwards the transaction is settled per the agreement (i.e., shares are exchanged for cash), and the traders go their separate ways. However, since a short sale involves selling shares borrowed from a third party, there are actually two transactions taking place: a share loan and a share sale, the former of which remains unresolved until the share loan is repaid in kind.
One way to illustrate the mechanics of this type of transaction is by example. Consider the hypothetical firm Gleason Gears. To short shares of Gleason Gears, the short seller (the share borrower) typically arranges a share loan by finding a share lender. If a lender is located, a loan is negotiated between the short seller and the lender. Once negotiated, the short seller is able to sell the borrowed shares to a purchaser just like a regular sale. From the perspective of the purchaser, the transaction is like any other: the buyer receives shares of the stock in exchange for cash, and the transaction is completed. On the other hand, the short seller is indebted to the share lender and has an outstanding share loan until he repurchases and returns shares of Gleason Gears. This is known as covering the short position.

**Locating Shares to Borrow and Naked Short Selling**

Shares sold short must be borrowed from an incumbent holder that must be located. Unlike a centralized marketplace, such as the New York Stock Exchange (NYSE) or a bond pit where traders aggregate, there isn’t currently a central location where traders get together to borrow and lend shares. Despite the important role of the share lending market, it is a relatively decentralized and informal marketplace. While there have been innovations over the years, the market was recently described as “relatively opaque”. In a 2004 publication, Jeff Cohen and others even noted that the market was “dominated by loans negotiated over the phone between borrowers and lenders”.

Given share location constraints, short sellers usually borrow shares from large institutions and index funds. Such institutions lend out shares through programs with custodial banks that cater to short sellers and their brokers. Beyond these large lenders and structured programs, short sellers may also borrow from broker-dealers with extra share supplies, proprietary trading desks, and even retail margin accounts.

Unsurprisingly, such a primitive market structure does not always facilitate seamless share location. In a 2002 paper, Darrell Duffie and his co-authors showed that in some cases the effect of share search frictions can be strong enough to push asset prices above the valuation of even the most optimistic investors. Recent empirical research also suggests that search costs represent significant barriers to short selling, and that the structure of the equity lending market generally benefits lenders, as the difficulty in finding shares gives them the ability to set higher fees.
Naked Short Selling and Regulation SHO

Since shares can sometimes be difficult to borrow, some traders have resorted to short selling without borrowing, or even locating shares. Short selling without borrowing shares is known as naked short selling. Naked short selling has been identified by regulators, CEOs, and many private investors as a source of market instability and even potential manipulation. For instance, in the early days of the 2008 financial crisis the bond insurer MBIA complained to Congress about unfair speculation, claiming that “self-interested parties have gone to substantial effort to undermine the market confidence that is critical to MBIA’s business.” Corporations like MBIA, and a chorus of others, have complained to regulators about abusive short selling, and have had some success in curbing it.

The response by US regulators to abusive short selling has been measured and incremental. One of the first federal regulations was the SEC’s adoption of Regulation SHO that became effective on 5 January 2005. Among other rules, Regulation SHO has a share “locate” requirement that prohibits broker-dealers from short selling without borrowing or arranging to borrow securities, or have reasonable grounds to believe that securities can be borrowed. Due to concerns about shocks to the market mechanism, market makers, and specialists in stock markets are exempt from the share location requirement. Options market makers were initially exempt, but became subject to share location requirements as part of emergency regulations adopted in September 2008.

Pricing a Share Loan and the Rebate Rate

Once a short seller identifies a suitable lender, they negotiate a share loan. To secure the share loan, the borrower pledges collateral, usually equal to 102% of the value of the shares. The collateral is almost always cash, but may be Treasury securities. The collateral is invested by the share lender and generates interest. The share borrowing fee is reflected in how much of that interest is given back to the share borrower, and is expressed in a rate known as the rebate rate. The more expensive a stock is to borrow, the more interest is kept by the share lender and the lower the rebate rate. In most share loans the rebate rate is close to what is known as the general collateral rate. The general collateral rate is approximately equal to standard overnight lending rates, like the well-known Federal Funds Effective Rate. If the rebate rate is close to the general collateral rate then short sellers are rebated interest at about the same rate as they would receive by lending the collateral out themselves, which implies that the cost to borrow shares is close to zero.

On the other hand, if shares being lent out are in short supply or the market for equity lending is otherwise impaired, then the rebate rate may be less than the general collateral rate. The rebate rate can even be negative, requiring the short seller to pay fees above and beyond the interest accrued on the collateral. Securities for which the rebate rate is below the general collateral rate are defined as being on special with the difference between the rates known as the specialness.

The rebate rate on shares can change on a daily basis depending on supply and demand, just like the price of a stock. This presents an added risk to short sellers, as the rebate rate on their collateral may change over the course of their share loan. The value of a share loan is also marked to market on a daily basis; changes in the price of the underlying stock affects the value of the share loan and the amount of collateral required.
Selling Borrowed Shares and Delivery Failure

Generally, once a lender is found and a share loan negotiated, the short seller sells the borrowed shares to a willing buyer in the open market. Once the transaction is executed, regulations require delivery of shares to the buyer over the following three trading days. Assuming there is an ample supply of loanable shares, the transacted shares are usually delivered to the buyer within that time, barring possible technical issues unrelated to short selling. If, on the other hand, loanable shares are hard to find or are in short supply, then share delivery may not occur by the end of the third day. In that case a delivery failure on the shares is triggered until the short seller delivers shares to the buyer.

Aside from incidental technical issues, delivery failure is a direct consequence of naked short selling. While delivery failure doesn’t tend to affect the purchasers’ capital gains, losses, or dividend payments on the transacted shares, unsettled trades can affect corporate governance, investor confidence, and the viability of the trading mechanism.

Persistent Delivery Failure and Regulation SHO

SEC Regulation SHO specifically addresses the issue of persistent delivery failures, which are longer lasting fails and symptomatic of structural market issues. Regulation requires designation of securities with persistent fails (above a specified number of shares and for five consecutive settlement days) as threshold securities, and targets them with additional rules. For instance, equity market makers with outstanding delivery failures may no longer rely on the bona-fide market making exception in effecting short sales. Threshold securities are also subject to what is known as a close-out requirement. This requires broker-dealers to close out any failure to deliver that has persisted for 10 settlement days by buying shares to satisfy delivery.

Monthly Delivery Failures and Threshold Security Counts

April 2004 – February 2013

Delivery failure and threshold security designation has become less pervasive since late 2008.
Initially, there were two exceptions to the close-out requirement. The first exception, called the “grandfather” provision, exempted fails to deliver on trades that occurred before the stock became a threshold security from close-out. For example, if a security was designated a threshold security on Wednesday, then shares that failed to be delivered the Tuesday before would not be subject to close-out. The second exception, called the “options market maker exception,” exempted options market makers from the close-out requirement if their delivery fails arose from hedging options positions created before the stock became a threshold security.

The “grandfather” provision was eliminated on 15 October 2007, while the “options market maker exception” was eliminated on 17 September 2008. Delivery failures and threshold security designations have become much less widespread since late 2008, as illustrated above. The timing of the drop-in delivery failures and threshold security designations corresponded with the elimination of the options market maker exception and implementation of other regulation as part of the September 2008 emergency order.

**Determining if a Stock is Short-Sale Constrained**

For the purposes of a market efficiency analysis, a stock is short-sale constrained if the cost to execute a short sale prevents traders from swiftly incorporating their information or beliefs into market prices through transactions. In such a situation, prices do not respond rapidly to a prospective short seller’s information and the market may be deemed inefficient.

To understand if a particular stock is short-sale constrained, one might simply determine if the rebate rate for the stock is unusually low or if share loans are being made at all. While this may help in understanding the monetary cost of short selling, comprehensive rebate rates are not generally available since the share lending market is not a formal, fully centralized market.

Despite this lack of centralized rebate rate data, researchers may be able to obtain subsets of rebate rates from vendors who typically collect such data from market participants. In addition to considering rebate rates, researchers have identified other factors suggestive of short-sale constraints, such as:

1. Reviewing violations of the put-call parity condition in options markets.
3. Estimating supply and demand for loanable shares using institutional ownership and short interest as proxies for supply and demand, respectively.
Low or Negative Rebate Rates Suggests that Short Selling is Constrained

The monetary cost of borrowing shares to short sell is measured by the difference between the rebate rate and the general collateral rate, which is the specialness cost of the share loan, as previously defined. The duration of the loan also affects the overall borrowing cost. For example, if a short seller borrows Gleason Gears stock and the general collateral rate is 2.5% per year, then a rebate rate of 2.5% implies that borrowing Gleason Gears stock is cheap since all interest is rebated to the short seller. If shares of Gleason Gears are in short supply then the rebate rate may fall to 1.0%, implying a 1.5% specialness rate. In this case, if an investor borrows $1 million worth of stock for 30 days then he must deposit $1.02 million of collateral (102% of the loan value) and forfeit $1,275 in rebated interest to short the stock. If supply were to tighten further and the rebate rate to fall to negative 1.5%, then the specialness rate would be 4% of the value of the collateral pledged.

Although studies into rebate rates have been limited in both size and duration, research has found that most stocks can be borrowed at rates close to the general collateral rate, or at low cost. Using 18 months of rebate data from a large institutional lending intermediary, Gene D’Avolio found that, at most, only 16% of stocks in his data were impossible to short. Of the stocks lent out, 91% cost less than 1% per year to borrow, and less than 1% of the stocks on loan had negative rebate rates. D’Avolio singled out Krispy Kreme Doughnuts and Palm as notable examples of stocks with high lending fees, as they exhibited specialness rates as high as 50% and 35%, respectively.

Data on rebate rates can help test market efficiency and evaluate:

1. the degree to which traders with negative information are being excluded from the market, since traders subject to high lending fees may not arbitrage stocks down to the efficient market price,
2. how much traders are willing to pay for the ability to short sell the security, which indicates how much they believe their information is worth, and
3. if loanable shares were available at all, because non-existent rebate data implies that share loans may not have taken place.

Although rebate rates reflect the monetary cost of particular share loans made, they may not reliably indicate share borrowing costs that all short sellers are subject to. Due to the decentralized and informal nature of the equity lending market, it is conceivable that two borrowers may receive different rebate rates on collateral posted for shares of the same stock. A 2013 paper by Adam Kolasinski and his co-authors highlighted this point empirically. They analyzed rebate rates from 12 equity lenders and found a significant level of dispersion in loan fees for the same stock over the same time period. They specifically found that loan fee dispersion was highest when average fees were abnormally low or abnormally high. Therefore, while a snapshot of loan fees from a single lender may provide insight into short sale constraints faced by some borrowers, if possible it is best to draw conclusions using multiple indicators of short sale constraints that potentially include rebate rates from several market participants.
Violations of the Put-Call Parity Condition Implies that Short Selling is Constrained

If short selling a stock is expensive, then one should also expect contracts giving the holder the option to sell the stock to be expensive. A contract giving the holder the option to sell a stock at some point in the future is known as a put option. Research has shown that put options trading at higher than expected prices, especially over long periods of time, can indicate that the underlying stock is short-sale constrained.

There are two basic types of stock options. Put options give the holder the option to sell shares, while call options give the holder the option to buy shares. Standardized, exchange-traded options contracts are available for many listed stocks and, specifically, give the holder the right to transact in a specified number of shares (usually 100) at a specific price (the strike price) until a specific date (the expiration date). Puts and calls are generally issued in pairs: if a call option is listed with a $10 strike price and a June expiration date, then a put option with similar attributes is generally listed, too.

Since stock and options prices are related to the same underlying asset, the prices of the securities are related. The relationship between the prices of a stock and its options traded in an efficient market is known as the put-call parity condition. Technically, it specifies that the price of a call option plus the discounted strike price should equal the price of the analogous put option plus the underlying stock price.

The Put-Call Parity Condition

\[
\text{Call Option Price} + \frac{\text{Discounted Option Strike Price}}{1 + \text{Discount Rate}^{\tau}} = \text{Put Option Price} + \text{Stock Price}
\]

The relation between the prices of call and put options, their common strike price, and the underlying stock price.

To gain intuition, consider another example of Gleason Gears. Assume that Gleason Gears stock is trading at $12 per share and that put and call option contracts on the stock with $13 strike prices are about to expire. At this point, a call giving the holder the right to buy shares at $13 is worthless, as one would be better off buying shares at the market for $12. Since the option is about to expire, the discounted strike price equals the $13 strike price. A put option giving the holder the right to sell shares at $13 is worth $1 per underlying share, which is the expected profit from buying shares at the market for $12 and selling them with the put at $13. Using the put-call parity equation, one can see that the given combination of prices conforms to the condition: a $0 call option plus a $13 strike price equals a $1 put option plus a $12 stock price.
In the absence of structural constraints to arbitrage, the put-call-parity condition generally holds if trading is frequent, as arbitrageurs keep prices of the securities in check through purchases and sales. For example, if an arbitrageur observed that the price of a put contract described above was trading at $2 instead of $1 then he could benefit by selling the expensive put contract. This position could be hedged by purchasing a call option and a bond that paid $13 upon expiration of the contracts, and short selling a share of Gleason Gears. This combination of securities does not expose the trader to any risk from changes in the stock price, but does generate an immediate profit. This simple hedge is captured by rearranging the put-call parity equation.

**Rearrangement of the Put-Call Parity Condition**

\[
\text{Put Option Price} = \text{Call Option Price} + \frac{\text{Discounted Option Strike Price}}{\text{Stock Price}}
\]

As a simple hedge, one may sell one “side of the equation” and buy the other. Sell a put contract and offset this position by buying a call and a bond with a face value equal to the strike price, and shorting the underlying stock.

Notice that to profit from the mispriced put option, the arbitrageur must short sell Gleason Gears stock. Since the put-call parity relation depends on a well-functioning market for short selling, if short selling is monetarily expensive or is otherwise risky then the put-call parity can break down. Consequently, while this arbitrage strategy works if the stock isn’t short-sale constrained, it can fail if short selling is expensive or impossible, and as a result, violations of the put-call-parity equation may appear.

A number of researchers have found that put-call parity violations persist when short-sale constraints prevent market participants from engaging in arbitrage. In a 2003 study, Eli Ofek and Matthew Richardson found that during the dot-com bubble, Internet stocks with high levels of short interest and low rebate rates were more likely to violate put-call parity. Subsequently, in a 2004 study, using proprietary rebate rate data between July 1999 to November 2001, Eli Ofek and others found that not only were borrowing costs related to put-call parity violations in terms of frequency, but also that the magnitude of the put-call parity violation was related to the cost of borrowing shares. As part of their 2009 study, Robert Evans and others “show that shorting costs move options out of parity,” and that “synthetic shorts constructed from options trade below spot market prices when shorting is costly...and this disparity grows as the rebate falls,” driving the cost of shorting higher.

Based on these findings, a review of put-call parity violations in the options market may be a valuable tool in determining whether short sellers were constrained, which negatively affects market efficiency. A potential drawback of generally relying on options to determine if a stock is short-sale constrained is that not all stocks have listed options. In that case, other indicators may be utilized.
Persistent Delivery Failure and Threshold Security Designation are Associated with Short-Sale Constraints

Settlement of a stock transaction, when shares and cash are exchanged, is fundamental to a financial market. The failure of a seller to deliver shares to a buyer within the settlement period may stem from technical issues or from a shortage of inexpensive shares to borrow. Technical fails are usually incidental and quickly resolved. On the other hand, persistent delivery failures involving a large number of shares may indicate that borrowing shares is expensive or they are in short supply, which implies that short selling is constrained.

Market participants with access to a cheap source of loanable securities will typically not have a problem borrowing, selling, and delivering them to buyers. On the other hand, market participants with the option to fail to deliver shares have an incentive to do so when borrowing shares is expensive. Therefore, delivery failure can also indicate the presence of share borrowing costs if market participants have the option not to deliver shares.

Current regulation only exempts equity market makers from the “locate” requirements of Regulation SHO. Options market makers were also exempt until September of 2008. Exceptions from the share location rules effectively provides these market participants with an option to fail to deliver shares, and studies have shown that they tended to do so when share-borrowing costs were high.

Using delivery failure data from 2003 and 2004, Leslie Boni investigated trends in delivery failure by market makers and presented “evidence consistent with the hypothesis that market makers strategically fail to deliver shares when borrowing costs are high.” Furthermore, she specifically focused on the relationship between share-borrowing costs and delivery failure and “provide[d] some evidence that the likelihood of persistent fails increases with borrowing costs.” This implies that persistent delivery failures in a security may indicate that short selling is expensive and that short sellers of that stock are broadly constrained.

While Ms. Boni analyzed the conduct of market makers in general, a study published in 2009 by Richard Evans and others showed that options market makers, also previously exempt from the described “locate” and close-out requirements, may strategically fail to deliver shares with high borrowing fees. Given this, using data from an options market maker, the authors “conclude that [delivery] failure is tightly linked to low rebates.”

The Options Market Maker Exception

These studies specifically focused on how market makers subject to special exemptions strategically failed to deliver expensive or hard to locate securities rather than borrowing them. Market makers in the options and equity markets have specialized roles as reliable counterparties to traders and arbitrageurs; however, they operate in fundamentally different ways. Equity market makers provide liquidity to counterparties by anticipating or reacting to the flow of transactions and usually hold an inventory of shares. Options market makers hedge their positions in options contracts with countervailing positions in the underlying stock, which sometimes requires holding short positions for months on end.
If options market makers are exempt from share delivery requirements, it is conceivable that informed options traders (using the market maker as a counterparty) could bet against the stock of a company and shift the burden of share delivery to the exempted options market maker. Research released in 2008 by the SEC’s Office of Economic Analysis found evidence indicating that such a trading strategy was common in securities with high borrowing costs. They specifically proposed that “investors who previously failed to deliver in the equity market have...moved to the options market to establish a synthetic position. Since the option market makers still enjoy an exception to the close-out rule and tend to hedge their positions in the equity markets, the fails may now be coming from the option market makers instead of the equity investors themselves.”\(^\text{71}\) Hence, it is plausible that traders, being unable to cheaply short a security, may have taken negative positions using options. If the options market maker facilitating the trade is also unable to cheaply borrow shares they may legally opt to fail to deliver instead, which suggests that the existence of persistent delivery fails indicates that short sellers are constrained.

Given the potential use of the options market maker exception as a conduit to take informed negative positions in an otherwise short sale constrained stock, one may attempt to argue that fails to deliver actually indicate market efficiency. Concretely, one may propose that information known by arbitrageurs may be fully impounded into equity prices vis-à-vis their options positions that are hedged via exempted delivery failure. This is incorrect for the following reasons:

1. Results from research by Richard Evans et al. show that put-call parity is still violated when there are borrowing costs, and the violation grows as borrowing costs increase. Violation of the put-call parity condition indicates that prospective short sellers using the options markets to bet against a security are still subject to trading costs.

2. The “options market maker exception” only applied to delivery failures that occurred before a security was designated a threshold security. So once a security is designated a threshold security, options market makers may not longer fail to deliver except to maintain previously hedged positions.

3. The “options market maker exception” was fully eliminated in 2008.\(^\text{72}\)

**Threshold Security Designation**

As previously described, Regulation SHO stipulates that securities with large, persistent delivery fails be designated threshold securities and subjected to additional regulation. Designation of a security as a threshold security further impinges its market efficiency as traders and their brokers with delivery failures are no longer able to rely on “reasonable grounds” that shares are available to borrow before effecting short sales. Rather, such market makers are required to pre-borrow or arrange to borrow shares; otherwise they are barred from effecting short sales.

Being labeled a threshold security also effectively closes the “options market maker exception” to new options positions, which blocks any marginal negative sentiment of options traders from flowing through to the equity markets via delivery fails. As noted above, in such a case, options market makers also must close out any delivery failures that are not needed to hedge options transactions that were effected before the stock was designated a threshold security.
Research has specifically found a relationship between threshold security designation and short-sale constraints. In a 2011 study, Don Autore and his co-authors found that threshold listings and short-sale constraints were closely related, insofar as “threshold listings reveal information about the binding nature of short sale constraints.” The SEC has also recently concluded that “threshold securities are hard-to-borrow and therefore command large fees in the stock loan market.”

These findings imply that delivery failures—if they do not stem from incidental technical issues—suggest that short sale constraints are binding, which negatively affects market efficiency. Furthermore, given that threshold security designation is designed to further restrict short selling, once a security is designated as such market efficiency may be further impaired.

**Delivery Failure Since the September 2008 Emergency Order**

Since late 2008, when the options market maker exception was lifted and other emergency regulations were implemented, there has been a substantial reduction in delivery failures and threshold security designations, per the chart on page 9. The reduction does not necessarily imply that fewer stocks are short-sale constrained. Rather, due to more restrictive regulations, the reduction suggests that fewer market participants have the option to fail to deliver shares when short-sale constraints are binding, actually indicating an overall reduction in liquidity even though there are fewer reported delivery failures. As a result, subsequent to the September 2008 tightening of regulation, it is more likely that a stock could be short-sale constrained without exhibiting persistent delivery failures.

**A High Level of Demand for Loanable Shares Relative to Supply Suggests that Short Selling is Constrained**

In a share lending market, it is intuitive that equilibrium rebate rates relate to the relative amount of supply and demand for share loans. A high level of demand for shares tends to increase lending fees (decreasing the rebate rate), as will a dearth in supply. Likewise, low share demand will tend to lower lending fees (increasing the rebate rate), as will excess supply. Despite being unable to observe equilibrium rebate rates, one might infer the degree of short-sale constraint based on the relative levels of supply and demand for loans.

Research conducted by Paul Asquith and others applied such an approach to estimating short-sale constraints. In their model, the level of institutional ownership was used as a proxy for the supply of loanable shares, and the level of short interest was used as a proxy for the demand for loanable shares. Since institutions are the main suppliers of share loans, such a proxy makes intuitive sense, and is furthered by Gene D’Avolio’s finding that about 55% of the variability of loan supply is explained by institutional ownership in his data. Likewise, the number of shares shorted, as indicated by the level of short interest, may reflect demand for loanable shares. Their logic is that if short interest is high (with a short interest ratio in the 99th percentile) and institutional ownership is low (in the lowest third of ranked institutional ownership), then the stock is more likely to be expensive to borrow and thus constrained.
Their results show that between 1988 and 2002, equally weighted portfolios—but not market value weighted portfolios—of constrained stocks systematically underperformed the market. Systematic underperformance of a portfolio of securities should not be observed in a well-functioning marketplace, since arbitrageurs mitigate such trends through sales of overpriced securities. The author’s suggest that such underperformance implies that arbitrageurs were unable to rapidly short sell shares to their efficient price level.

Although there was a documented trend of underperformance of some securities, the authors noted that stocks in the mispriced portfolios tended to have small market capitalizations. This, coupled with their finding that such trends only existed in portfolios where stocks were weighed equally rather than by market value, implies that smaller firms had a higher tendency to be mispriced. Although they concluded that short-sale constraints were not widespread, their findings suggest that stocks with small market capitalizations, low institutional ownership, and high short interest were more likely to be short-sale constrained, which limits market efficiency.

**Conclusion**

The efficiency of the market in which a security trades is often a crucial component of class certification in securities litigation. In these cases, market efficiency analysis by the courts is often centered on analysis of the Cammer factors. A proper analysis of one of these factors, the existence of arbitrageurs, often requires examining whether a class of arbitrageurs, potential short sellers, are actually able and willing to engage in short-selling activity.

Short-sale constraints have been shown to result in security mispricing and affect the speed at which prices respond to news, thus violating key tenets of market efficiency as cited in the Basic v. Levinson decision. More directly, the subsequent Polymedica decision in the First Circuit supported the contention that short-sale constraints affect the “information efficiency” of securities prices, and that such analysis complements traditional Cammer factor analysis. In fact, short-sale analyses go to the heart of a key factor discussed in Cammer: that the arbitrage mechanism that provides for market efficiency is operating effectively for the security at issue.

Fortunately, there are ways to examine the feasibility of short selling and to observe indicators of constraints on that activity. One approach is to quantify such constraints with share borrowing costs, as captured by rebate rate data. Other methods, including the use of accepted proxies for short-sale constraints such as put-call parity violations, share delivery metrics, and the supply and demand for loanable shares, may provide important insights into the existence and magnitude of potential constraints. Thus, when data are available to evaluate whether or not short selling is constrained, it is important to consider this key driver in any assessment of market efficiency.
Notes

5 For details of each factor see Cammer v. Bloom, 711 F. Supp. 1264 (D.N.J. 1989). A SEC Form S-3 is a simplified registration statement that may be used by companies that have met particular reporting requirements.
6 Other potentially relevant factors include the bid-ask spread, which is the difference between the bid and ask prices of the security, whether returns are predictable, and the market capitalization of the security.
10 Ibid.
11 Ibid.
12 Ibid.
13 Ibid.
15 SEC Halts Short Selling of Financial Stocks to Protect Investors and Markets”, SEC News Release, 2008-211.
16 Ibid.
17 Ibid.
19 Ibid, p. 347.
22 See Cammer v. Bloom, 711 F. Supp. 1264 (D.N.J. 1989), citing Alan A. Bromberg and Lewis D. Lowenfeld, Securities Fraud & Commodities Fraud §8.6 (1988), (A developed market “is principally a secondary market in outstanding securities. It usually, but not necessarily, has continuity and liquidity (the ability to absorb a reasonable amount of trading with relatively small price changes).”).
24 Broker-dealers are required to either locate securities or have reasonable grounds to believe that securities can be borrowed prior to short selling. Equity market makers engaged in bona-fide market making activities are exempted from this rule.
25 This assumes that the shares are actually “delivered” upon settlement from the short seller to the purchaser, a fine point of the transaction that is discussed below.
26 From 1926 to 1933 there was a centralized stock loan market on the floor of the NYSE known as the “loan crowd”. For details of the operation of this market see Charles M. Jones and Owen A. Lamont, “Short-Sale Constraints and Stock Returns,” Journal of Financial Economics, Vol. 66, No. 2, 2002.
34 The SEC generally refers to these borrowing procedures as share “locate” requirements.
35 Exemptions are discussed below. For additional details see http://www.sec.gov/spotlight/shortsales.shtml.
The “general collateral” interest rate is a term borrowed from the bond repo market and is the rate applied when the underlying asset (in this case, loaned shares) are not in particular demand. Researchers, such as Geczy et al. have found these rates to be close to overnight lending rates. See Christopher C. Geczy, David K. Musto, and Adam V. Reed, “Stocks are Special Too: An Analysis of the Equity Lending Market,” Journal of Financial Economics, Vol. 66, No. 2, 2002.

Beyond the total supply of loanable shares, researchers have also found that rebate rates are lower (i.e., borrowing costs are higher) if lenders are difficult to find or don’t have to compete with each other. See Adam C. Kolasinski, Adam V. Reed, and Matthew C. Ringgenberg, “A Multiple Lender Approach to Understanding Supply and Search in the Equity Lending Market,” Journal of Finance, Vol. 68, Is. 2, April 2013.

Regulations stipulate that equity trades settle within three settlement days after the transaction date. For details see http://www.sec.gov/investor/pubs/tplus3.htm. Shares not delivered within this period trigger a delivery failure, which broker-dealers may not systematically engage in unless they are exempt.

The annual rate of 1.5% multiplied by $1.02 million equals $15,300, which is the annual fee. Since the loan is for 30 days, $15,300 is multiplied by 30/360, which equals $1,275.

Threshold security listings for multiple days would be counted as multiple failures. For details see SEC Release No. 34-58572 dated September 17, 2008 and SEC Release No. 34-57775 dated October 14, 2008. Elimination of the options market maker exception coincided with implementation of Regulation SHO Rule 204T, which imposed “a penalty on any participant of a registered clearing agency, and any broker-dealer from which it receives trades for clearance and settlement, for having a fail to deliver position at a registered clearing agency in any equity security.” The relevant provisions of this rule were made permanent in July 2009. For details of Rule 204 see SEC Release No. 34-58572 dated September 17, 2008 and SEC Release No. 34-60388 dated July 27, 2009.

Vendors may offer data collected from market participants such as agent lenders, or offer price data from proprietary securities lending platforms that match share borrowers and lenders. Two well-known data vendors include: Markit Securities Finance (http://www.markit.com/en/products/data/securities-finance/securities-finance.page) and Quadriserv, Inc., which also operates a securities lending market (http://www.quadriserv.com/).

The number of fails to deliver is the aggregate balance level outstanding recorded on the National Securities Clearing Corporation’s Continuous Net Settlement (CNS) system. This includes all NYSE, NASDAQ, AMEX, and OTCBB securities, per the definition of CNS, available at http://www.dtcc.com/downloads/products/learning/Settlement.pdf. Share delivery fails are in shares per day, so shares not delivered for multiple days would be counted as multiple failures. For details see http://www.sec.gov/foia/docs/failsdata.htm. Threshold security listings are the total number of securities designated on a daily basis as such by the NYSE, NASDAQ, and AMEX. OTCBB securities are not included in the threshold security counts.


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The annual rate of 1.5% multiplied by $1.02 million equals $15,300, which is the annual fee. Since the loan is for 30 days, $15,300 is multiplied by 30/360, which equals $1,275.


Ibid.


Ibid.


This describes an American options contract, which can be exercised at any point up until expiration. This differs from a European options contract that can only be exercised at expiration.
This specific condition holds for European-style options contracts. For American-style options, a similar boundary value condition holds and may be found on page 175 of Options, Futures, and Other Derivatives, Fifth Edition, John C. Hull, Pearson Education, Prentice Hall, 2002. The discounted strike price equals the strike price multiplied by a discount factor. The discount factor equals the price today of a bond worth $1 as of the expiration date of the option.

Options that expire in the money often are automatically exercised, so one does not have to worry about not having time to obtain and exercise the option. See http://www.cboe.com/LearnCenter/Concepts/Beyond/expiration.aspx ("The Options Clearing Corporation has provisions for the automatic exercise of certain in-the-money options at expiration, a procedure also referred to as “exercise by exception.” Generally, OCC will automatically exercise any expiring equity call or put in a customer account that is $0.01 or more in-the-money, and an index option that is $0.01 or more in-the-money. However, a specific brokerage firm’s threshold for such automatic exercise may or may not be the same as OCC’s.")

Arbitrage in this situation is in the traditional sense of buying in one market and selling in the other.


Leslie Boni, “Strategic Delivery Failures in U.S. Equity Markets,” Journal of Financial Markets, Vol. 9, No. 1, 2006. While Ms. Boni’s data precedes SEC Regulation SHO, similar rules were enforced by self-regulatory organizations such as the NASD and the NYSE.

See SEC Release No. 34-58572 dated September 17, 2008. The options market maker exception was permanently eliminated, per SEC Release No. 34-58775 dated October 14, 2008. Other relevant provisions, including Rule 204T, were also made permanent, per SEC Release No. 34-60388 dated July 27, 2009.


A short interest ratio is the number of shares short divided by the number of shares outstanding.

The definition of a stock with a small market capitalization varies, but is generally between $300 million and $2 billion. Of the 54 stocks in the most shorted portfolio (in the 99th percentile), Asquith, et al. find that 51 have market capitalizations between $140 million and $1.5 billion. See Paul Asquith, Parag Pathak, and Jay Ritter, “Short interest, institutional Ownership, and Stock Returns,” Journal of Financial Economics, Vol. 78, No. 2, November 2005.

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Contact
For further information and questions, please contact the author:

Stefan Boettrich
Consultant
NERA Economic Consulting
+1 212 345 1968
stefan.boettrich@nera.com

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