# Sheep in Wolves' Clothing: Using False Signals of Demand to Execute a Market Power Manipulation

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## 1 Introduction

The most famous–or infamous–type of commodity market manipulation involves a corner, in which a trader accumulates a long futures position that exceeds the supply of the commodity that he does not own, and which is available at delivery points. This extreme type of manipulation has led courts and regulators to utilize comparisons of a long's position to deliverable supply to determine whether the long had cornered the market, and could have caused the price to be artificially high.

It is plausible that a long position in excess of deliverable supply is a *sufficient* condition to exercise market power, but courts and regulators have often treated it as a *necessary* one.[1] In this article, I demonstrate that it

[1] See, for example, Great Western Food Distributors v. Brannan 201 F.2d 476 (7th Cir. 1948) ; Volkart Brothers, Inc. v. Freeman 311 F.2d 52 (5th Cir. 1962); . Cargill, Inc. v. Hardin, 452 F.2d 1154, 1174 (8th Cir. 1971); *in re* Cox & Frey Comm. Fut. L. Rep. (CCH) P23,786; [1986-1987 TRANSFER BINDER].

is not. Specifically, I show that a long's market power depends on shorts' beliefs regarding whether the long will consume what they deliver to him. If shorts believe that the long will not consume the commodity, but will re-sell it after delivery, a result in Pirrong (1993) shows that long position in excess of supply at the delivery market is indeed a necessary condition to exercise market power. In this article I demonstrate that if shorts believe that the long will consume the commodity, he faces a downward sloping demand curve for the contracts he owns even if his position is smaller than the stocks in the delivery locations. Consquently, if shorts believe the long will consume the commodity, a position in excess of deliverable supplies is *not* a necessary condition to exercise market power.

Thus, the standard test for market power applied in manipulation cases, and in the regulation of commodity futures markets, is implicitly premised on a particular assumption about what shorts believe a long will do with what they deliver to him. This raises the question of whether this assumption is indeed valid, or whether in fact there may be situations in which shorts believe that a long *might* consume what they deliver. If so, then a long with a position smaller than deliverable supply can exercise market power, i.e., can engage in a market power manipulation.

This article presents a theory based on signaling models first developed by Spence (1973), in which there is some positive probability that a large long who places a high value on the physical commodity and will consume what is delivered to him, but there are other longs who place a low value on it and will not consume it. Further, shorts do not know which type of long stands for delivery. In the model, a low-valuation type of long exploits this uncertainty and successfully executes a market power manipulation by misrepresenting his demand for the commodity. He misrepresents demand by offering to sell his positions (which allow him to demand delivery of the commodity) at a price that exceeds his valuation of the commodity, but which equals the valuation of the high-value type. Shorts do not know his true demand, and assign some positive probability to the possibility that the long's offer price reflects his actual valuation, and that as a result, he will consume any of the commodity delivered at that price. That is, there is a pooling equilibrium in which low-value demanders mimic high-value demanders. This allows them to liquidate some of their futures positions at an artificially high price, and profit accordingly even though they lose money when they re-sell what shorts deliver to them.

As a result of the manipulation, the price of the deliverable commodity (and hence the futures price) is artificially high, that is, it exceeds the value of the commodity to the firm stopping delivery. Moreover, the manipulation succeeds even though the long's position is smaller than inventories in the delivery market. Thus, when demanding deliveries at a price that exceeds his true valuation, a long can cause an artificially high price even when he has not fully cornered the market by amassing a position in excess of deliverable supplies as traditionally defined as the inventories at delivery locations.

The remainder of this article is organized as follows. Section 2 analyzes the delivery supply curve, and demonstrates how this curve depends on shorts' beliefs of whether the long will consume the commodity they deliver to him. Section 3 presents a model of a signaling game with different types of longs. If shorts do not know the long's type with certainty, a long who places a low value on the commodity can exercise market power even with a position that is smaller than deliverable supplies. Section 4 reports some implications of the theory for prices, the conditions under which manipulation can succeed, the incentives of a manipulator to deceive shorts about his true type, price and basis volatility, and the welfare impacts of this type of manipulation. Section 5 summarizes.

# 2 The Delivery Supply Curve

Pirrong (1993) demonstrates that the marginal cost of delivery–the delivery supply curve–determines the price at which the holder of a long futures position can liquidate his position. Since shorts have the option of delivering or liquidating their positions, the delivery supply curve determines their willingness to pay to repurchase their futures contracts. If the delivery supply curve is upward sloping over a range of deliveries smaller than a long's position, the long faces a downward sloping demand curve for his position, and therefore has market power. Exercising this market power is a form of manipulation (Pirrong, 1993, 1996).

Crucially for an analysis of how deception facilitates manipulation, Pirrong (1993) shows that the delivery supply curve depends on shorts' beliefs on whether or not a long will consume what is delivered to him. The bulk of the analysis in Pirrong (1993) relates to the case in which shorts believe that the long will re-sell what is delivered, but his model of "pure monopoly manipulation" evaluates the case in which the long retains ownership of, or consumes, what is delivered.

The dependence of the delivery supply curve on shorts' beliefs about the long's post-delivery use of the commodity can be demonstrated in a variety of models. In the context of the spatial model analyzed in Pirrong (1993), sellers at location $i$ sell $y_i$ units to shorts to deliver and anticipate that they will not be able to repurchase these units because the long will taking delivery will consume them (or otherwise find a way to withhold them post-delivery), they charge a price equal to $P_i(q_i^i - y_i)$, where $P_i(.)$ represents the demand curve at $i$ and $q_i$ is the inventory at location $i$. If, conversely, they anticipate that the long will re-sell after delivery, and that $s_i > 0$ units will return to location $i$, the owners at $i$ charge $P_i(q_i^* - y_i + s_i) < P_i(q_i^* - y_i)$. Thus, the cost of delivery is unambiguously higher when market participants believe that all of the deliveries will be consumed. This implies that expectations that the taker of deliveries will consume (or otherwise withhold) them shifts up the marginal cost of delivery function, and hence shifts out the large long's liquidation demand curve relative to the case in which participants believe that the long will re-sell deliveries.

Figure 1 illustrates this result. The figure presents two delivery supply curves derived based on the spatial model of Pirrong (1993). One is everywhere above the other: the higher supply curve corresponds to the case in which market participants expect that the taker of delivery will consume what is delivered, whereas the lower curve corresponds to the case in which market participants believe that the long will re-sell all of the deliveries tendered to him. Note that the no-resale supply curve is not just above the resale supply curve: it is steeper (less elastic). Thus, expectations that a large long will consume (withhold) deliveries and not-resell them increase a large long's market power because a given number of deliveries has a bigger impact on prices in this case.

Figure 1 illustrates another important finding that has implications for the analysis of the ability of a long to exercise market power: the no-resale supply curve is increasing for any quantity above zero, whereas the resale supply curve is perfectly elastic for a quantity corresponding to the supply of the commodity in the delivery market. Due to this perfect elasticity under the resale expectation, Result 3.1 in Pirrong (1993) states: "To manipulate, a trader who cannot exert monopoly power in the spot market must be able to demand delivery of more supply than is available in the delivery market." That is, under resale expectations, to cause an artificial price, a large long must have a position that exceeds deliverable supply.

In contrast, when resale is *not* expected, the delivery supply curve is sloping up for *any* positive quantity, and it is possible for a long to exercise market power even with a position that is smaller than deliverable supply.

There is another way of understanding this point. A large long can affect prices only to the extent that he can affect expectations about consumption and production. A long who (a) takes delivery of an amount less than the stocks of the commodity at the delivery point, and (b) is expected to resell this amount, does not affect expectations about consumption or production: since supplies available for consumption at every location are not expected to change as a result of the deliveries, prices do not change.

This result highlights the role of expectations in determining the likelihood and severity of manipulation. A long who through deed or word or silence can convince market participants that he intends to consume what is delivered has more market power, and can manipulate with a smaller position, than a long whom market participants believe will not consume or withhold what is delivered, but will resell it instead.

This result also obtains in a storage economy that is more analytically complex than the spatial economy studied in Pirrong (1993).[2] Indeed, if market participants believe that a large long will consume what is delivered, the long can exercise market power even in a non-spatial commodity (e.g., a single location commodity, or one which is costless to ship), and even if he takes delivery of less than deliverable inventories.

[2]One way of intpreting the demand curves in the 1993 model is that they include the demand for inventories, i.e., they are not flow demand curves.

This finding is a direct result of the theory of storage.[3] Even though transportation costs are zero, a friction–namely, a non-negativity constraint on storage–still plays an important role here. In the presence of this constraint, *ceteris paribus* an increase in demand increases prices and causes inventories to decline. Furthermore, this price increase occurs even if the inventory decline resulting from the demand shock is smaller than the total amount of inventory on hand. Thus, an expected increase in demand, including an expected increase signaled by a long standing for deliveries, causes prices to rise. This means that a demand for deliveries that market participants interpret as an indication of higher demand causes prices to rise even if the demand for deliveries is smaller than inventories. Furthermore, the theory of storage implies that the larger the expected increase in demand, the greater the price increase. Thus, if a larger demand for deliveries leads market participants to expect a larger increase in demand, the supply of deliveries curve is upward sloping even if the demand for deliveries is smaller than inventories.

Figure 2 illustrates this finding. The figure presents the price of a storable commodity (on the vertical axis) as a function of demand $y$ (on the axis labeled "$y$ shock"), starting inventory (on the axis labeled "inventory").[4] Note that price is increasing in the demand shock $y$ and decreasing in inventory $x$. Therefore a demand increase that is expected to cause a drawdown in inventories causes price to increase. Thus, a demand for deliveries that market participants believe represents a demand for the commodity will increase

[3] See Pirrong (2011) and Wright-Williams (1990).

[4] This figure is derived by solving a dynamic storage model like that analyzed in Pirrong (2011). In the model, the demand for the commodity is iso-elastic, and the marginal cost of production is increasing and convex. There is a single demand shock that follows an Orenstein-Uhlenbeck process.

prices.

Figure 2 also illustrates that the effect is non-linear. In particular, the sensitivity of price to the demand shock is greater, the smaller are inventories. Thus, the delivery supply curve is less elastic when inventories are small. However, the delivery supply curve is less than perfectly elastic for all levels of inventory.

Figure 3 depicts another way of illustrating the role of expectations. This is the delivery supply curve based on the assumption that the long will consume all that is delivered, and hence inventories will fall by the amount of deliveries. The supply curve is derived from the solution of the same storage economy used to derive Figure 2. The horizontal axis of the figure is deliveries as a fraction of inventories. Note that the curve slopes up even when this fraction is less than one, meaning that a long can exercise market power even if his position is smaller than available deliverable inventories. In contrast, if market participants believe that the long will resell what is delivered, he could not exercise market power with a position smaller than inventories because the delivery supply curve would be perfectly elastic.[5]

The intuition is again that given an expectation that the long will consume what is delivered to him, others expect to consume less. Inventories decline, and this decline in inventories reduces future consumption, which raises the value of the commodity and causes its price to rise. In contrast,

[5]Figures 2 and 3 are derived from a model for a continuously produced (i.e., non-seasonal) commodity. For seasonal commodities, such as corn or wheat, the comparable figures depend on the time of year, and in particular, the time remaining to the next harvest. In general, the steepness of the delivery supply curve is greater for a given fraction of inventories consumed, the earlier in the crop year (i.e., the longer the time to the next harvest. Intuitively, early in the crop year an amount of incremental consumption that represents a given fraction of consumption during that period of the year represents a smaller fraction of stocks because the stocks held early in the crop year must satisfy consumption until the next harvest.

given an expectation that the long will resell, inventories, and hence future consumption, do not change, and as a result, prices do not change.[6]

Figure 4 presents delivery supply curves in a model of a spatial economy with storage under different assumptions about expectations regarding whether the long will consume. In the model, there are two locations. Furthermore, the commodity is produced in both locations at every period of time, but the quantity of production is random. Random shocks to production are independent across locations and over time. Furthermore, the commodity can be shipped at constant per-unit cost from one location to another. Location 1 is the delivery point for the futures contract, and deliveries can be made from stocks in the delivery market, or from shipments from Location 2.

The Figure depicts the delivery supply curves when market participants expect that the long will consume what is delivered, and when they expect that he will resell it. As in the simple spatial model, (a) the supply curve when it is expected that deliveries will be consumed is above, and less elastic than, the curve when it is expected deliveries will be re-sold, and (b) the supply curve when it is expected that deliveries will be consumed is increasing for any quantity of deliveries greater than zero, whereas the supply curve when it is expected that deliveries will be resold is perfectly elastic for some quantity above zero (which equals the initial inventories in the delivery market).

[6]Expectations can also affect the cost of delivering inventories committed to supplying sales contracts. A firm that owns inventory it intends to use meet sales commitments is willing to deliver these inventories at a lower price if it expects that the taker of delivery is going to resell the stocks than if it expects that the taker will not resell. In the former case, the owner of inventories realizes that he will be able to meet his sales commitments by re-purchasing what he has delivered, and thus does not need to incur the risk of defaulting on sales commitments, or the costs of acquiring replacement supplies.

# 3 Market Power Manipulation Through Deception

The preceding analysis demonstrates that if shorts believe a long will consume what they deliver to him, the demand curve for the long's contracts slopes down. This raises the possibility that a long who can fool shorts into believing that he will consume can exercise market power. This section presents a model of the "delivery end game" of a futures contract that demonstrates just that. Using an adverse selection/"hidden type" model, I show that a long who cannot consume the commodity efficiently may stand for delivery nonetheless because some longs who stand for delivery are efficient consumers, and shorts do not know which longs are efficient consumers, and which ones are not. Due to shorts' ignorance, an inefficient consumer long faces a downward sloping demand curve for his positions, exercises market power, and causes the futures price to be excessively high.

In the model are two kinds of futures longs: those who place a high valuation $\bar{P}$ on the deliverable for a quantity $X$, and those who place a lower value $\underline{P}$ on it for up to $X$ units. Both the high-value and low-value types have a long futures position of $X$.

If the high-valuation long takes delivery, he consumes the commodity (i.e., he is an efficient consumer), and this represents additional demand for the commodity that results in a reduction in stocks: in the argot of the grain trade, such a firm is referred to as a "strong stopper." If the low-valuation long takes delivery, he resells it because he cannot consume it efficiently (its value to him is lower than the competitive price) and does not deplete stocks. He resells at the competitive price $P_c$ net of a transaction cost $\tau$, where $P_c - \tau \geq \underline{P}$: the competitive price is determined by the level of stocks and demand in the cash market for the commodity.[7]

There are shorts who can cover their positions, or make deliveries. Shorts cannot observe the long's true type. Based on their information, shorts believe that the long places a high valuation on the deliverable with probability $p_H$. That is, the probability the long is a strong stopper is $p_H$, and the probability he is a weak stopper is $1 - p_H$.

The game proceeds as follows:

- The long chooses to sell futures positions at $\bar{P}$, or at $P_c$. That is, a long submits an offer to sell $X$ contracts at a price of $\bar{P}$ or $P_c$.
- Competitive shorts choose the number of deliveries to make. The positions not closed by delivery are liquidated at the long's offer price.
- The high-value long consumes what is delivered. The low-value long resells it for net proceeds of $P_c - \tau$ per unit.

Shorts can make delivery of $Q$ units of the commodity at a marginal cost $MC(Q)$ if the long consumes what is delivered, where marginal cost is increasing in $Q$, i.e., $MC'(Q) > 0$. The marginal cost of delivery is $P_c$ if the long does not consume: the marginal cost of delivery is $P_c$ if the long has a

[7]The high-valuation long may be "in position," that is, has a demand for the deliverable commodity because he has processing or merchandising operations at the delivery location, and thus can consume it efficiently. The low-valuation long may be a consumer, but "out-of-position" because his processing or merchandising operations are located elsewhere, and it is more economical to obtain the commodity from his local market: he is an inefficient consumer of the delivered commodity. The low-valuation long may buy futures nonetheless in order to hedge flat price risk. Most hedgers (long or short) in commodity futures markets are out-of-position, as is demonstrated by the fact that deliveries are a much smaller fraction of open interest than the fraction of positions held by hedgers.

low-valuation because shorts can repurchase what they deliver at that price.[8] (Equivalently, $P_c$ is an opportunity cost of a delivery because the holder of inventory can sell it to other consumers at that price.)

For reasons set out in Section 2, the marginal cost of delivery depends on whether the long consumes what shorts deliver because his consumption reduces supplies available to other consumers and raises the post-delivery spot price. Conversely, if the long does not consume the commodity, inventories do not decline and deliveries do not affect the consumption of others, and hence do not affect the post-delivery price. Since the opportunity cost of the marginal delivery is the post-delivery spot price, the marginal cost of delivery is increasing if shorts believe the long will consume, but is perfectly elastic at $P_c$ if they believe he will not consume.

Shorts choose the number of deliveries to maximize profits. This involves equating the expected marginal cost of delivery to the long's offer price (because the opportunity cost of delivering is purchasing a futures contract at the long's offer price).

The long can misrepresent his type. In a particular, a low-valuation long can pretend to be a strong stopper of deliveries and demand a price of $\bar{P}$ to sell his futures position. This can be an equilibrium, depending on $\tau$ for some specifications of shorts' out-of-equilibrium beliefs when the long offers to sell at $P_c$.

If both types demand $\bar{P}$, shorts have no information about the long's true

[8] One interpretation of the transaction cost $\tau$ that the low-value long incurs is that he can only resell to the party making delivery, who therefore possesses some bargaining power and can repurchase at price below $P_c$. If $\tau$ measures the discount at repurchase, the marginal cost of delivery to a low-value long is $P_c - \tau$ because the deliverer captures $\tau$ by repurchasing from the long. It is straightforward to see that this lowers the marginal cost of delivery and therefore results in more deliveries.

type, and estimate the expected marginal cost of delivery as:

$$MC^*(Q) = p_H MC(Q) + (1 - p_H)P_c$$

They choose $Q^*$ such that:

$$\bar{P} = MC^*(Q^*)$$

That is, they choose the number of deliveries so that the opportunity cost of delivery (repurchasing a futures contract at price $\bar{P}$) equals the expected marginal cost of delivery, where the expectation is taken over the long's type.

Under various assumptions about shorts' off-equilibrium beliefs this pooling equilibrium exists.

First consider that shorts believe that if a long offers $P_c$, he is a low-value type with probability 1. In this case, when the long offers to sell at $P_c$, shorts deliver quantity $Q_c$, with $Q^* < Q_c \leq X$.

The payoff to the high-value type when offering $\bar{P}$ is $X\bar{P}$: he gets $Q^*$ units of the commodity which he values at $\bar{P}$ and resells the remainder of his futures position $X - Q^*$ at a price $\bar{P}$. Under the shorts' out-of-equilibrium beliefs, his payoff when offering $P_c$ is $P_c(X - Q_c) + Q_c\bar{P} \leq X\bar{P}$. Thus, the high-value long has no incentive to defect from the pooling equilibrium.

The low-valuation long's payoff from pretending to be a high-valuation type is:

$$\Pi_{L,H}(\tau) = (X - Q^*)\bar{P} + Q^*(P_c - \tau)$$

The first term is the revenue from selling $X - Q^*$ futures contracts at the price $\bar{P}$, and the second term is the revenue from selling the $Q^*$ deliveries at a price (net of transactions cost) of $P_c - \tau$.

Given shorts' out-of-equilibrium beliefs, a low-valuation long's payoff from honestly revealing his type is:

$$\Pi_{L,L} = P_c(X - Q_c) + Q_c(P_c - \tau) = P_cX - Q_c\tau \leq XP_c$$

If $X > Q^*$, $\Pi_{L,H} > \Pi_{L,L}$. To see why, note that when $\tau = 0$, $\Pi_{L,H} = X\bar{P} + Q^*(P_c - \bar{P})$, and $\Pi_{L,L} = XP_c$, which implies $\Pi_{L,H} - \Pi_{L,L} = (X - Q^*)(\bar{P} - P_c) > 0$ for $X > Q^*$. Thus, for $\tau = 0$, the low-value type does not defect from the pooling equilibrium under the assumed out-of-equilibrium beliefs. Moreover, since $Q_c > Q^*$, $d\Pi_{L,H}/d\tau > d\Pi_{L,L}/d\tau$, defection does not occur for $\tau > 0$.

Similar results obtain under alternative out-of-equilibrium beliefs. If shorts believe that a long offering $P_c$ is a high-value type with probability $p_H$, shorts choose to deliver $\hat{Q}$, where:

$$MC^*(\hat{Q}) = P_c$$

because the opportunity cost of delivery is liquidating a futures contract at a price $P_c$. Note that $\hat{Q} < Q^*$. Here the high-value type's payoff from offering $P_c$ is:

$$P_c(X - \hat{Q}) + \hat{Q}\bar{P} < X\bar{P}$$

meaning that again that the high-value type will not defect from the pooling equilibrium.

The low-value type's payoff from offering $P_c$ is:

$$\Pi_{L,L} = P_c(X - \hat{Q}) + \hat{Q}(P_c - \tau) = P_c X - \hat{Q}\tau$$

With the assumed beliefs, there is a critical value of $\tau^* > 0$ such that (a) $\Pi_{L,H}(\tau^*) = \Pi_{L,L}$, (b) $\Pi_{L,H}(\tau) > \Pi_{L,L}$ for $\tau < \tau^*$, and (c) $\Pi_{L,H}(\tau) < \Pi_{L,L}$ for $\tau > \tau^*$. To see why, note that for $\tau = 0$, $\Pi_{L,H} > \Pi_{L,L}$, but $d\Pi_{L,H}/d\tau = -Q^*$ and $d\Pi_{L,L}/d\tau = -\hat{Q} > -Q^*$. Therefore, under both alternative out-of-equilibrium beliefs, there is a critical value of $\tau$ such that the pooling equilibrium exists.[9]

[9] A trembling-hand pooling equilibrium also exists.

This model demonstrates that a long can exploit shorts' uncertainty about his true valuation of the deliverable commodity to execute a market power manipulation. In this case, fraud–misrepresenting valuation or demand–makes market power manipulation possible where it would otherwise not be. In sum, a long can exercise market power, and liquidate futures positions at a supercompetitive price, by misrepresenting how much he values the deliverable commodity. He can misrepresent by refusing to liquidate except at a price that is in excess of his true valuation, but which some longs would be willing to pay.

# 4 Implications

The model generates a variety of implications relating to how the likelihood of misrepresentation depends on $p_H$, $X$, and the elasticity of the delivery supply curves; and how manipulation can occur when shorts are uncertain about the long's type, but would be impossible if they knew the long's type.

Consider how $\tau^*$ (and hence the existence of a pooling equilibrium) depends on $p_H$ when under the out-of-equilibrium beliefs shorts assume that a long offering a price of $P_c$ is high-value with probability $p_H$.[10] Some simple calculus produces:

$$\frac{dQ^*}{dp_H} = \frac{1}{MC'(Q^*)} \frac{P_c - \bar{P}}{p_H^2} < 0$$

Moreover,

$$\frac{d\Pi_{L,H}}{dQ^*} = P_c - \bar{P} < 0$$

meaning that a low-value type is more likely to pool with a high-value type when shorts believe it is likely that he is high-valuation. This is because

[10]With the alternative out-of-equilibrium beliefs, the low-value long always misrepresents his type, regardless of $p_H$.

it is costlier to deliver to high-valuation longs than low-valuation longs, so shorts deliver less when they believe the long will actually consume what is delivered.

It also implies that a low-valuation long finds manipulation more profitable, the more actual "strong stoppers" there are. In effect, the marginal cost of delivery is higher the more likely a stopper is a strong one, and as shown in Pirrong (1993), a higher marginal cost of delivery increases a long manipulator's profit. Furthermore, it reduces the cost of "burying the corpse," i.e., disposing of what is delivered to him at a loss. This occurs because a misrepresenting long receives fewer deliveries.

Crucially, the fact that the profitability of manipulation increases in shorts' estimation that the long is a strong stopper provides a motive for the low-value long to manipulate shorts' estimate of $p_H$ through statements or acts intended to convince shorts that he is a strong stopper even though he is not. Thus, deceptive statements or acts that raise $p_H$ make manipulation more likely, and more profitable.

The pooling (misrepresentation) equilibrium is also more likely, the larger is $X$. That is $d\tau^*/dX > 0$. This is because

$$\frac{d\Pi_{L,H}}{dX} - \frac{d\Pi_{L,L}}{dX} = \bar{P} - P_c > 0$$

Large low-valuation longs are more likely to misrepresent than small ones.

Furthermore, an analysis similar to that used to derive Result 3.9 in Pirrong (1993) shows that fraud is also more likely to occur, the steeper the marginal cost of delivery curve (i.e., the less elastic the delivery supply curve). The less elastic a the delivery supply curve, the smaller is $Q^*$, and thus the smaller the lying long's losses from selling the unwanted deliveries for a given value of $\tau$. Thus, manipulation is profitable for a larger value of $\tau^*$, the less elastic delivery supply.

Now consider how private information about valuation affects the circumstances under which a long can exercise market power. Note that $MC(Q)$ exceeds $P_c$ (the competitive price if the long has a low valuation) even if $Q$ is smaller than total inventories. This is an implication of the theory of storage. This theory implies that a demand shock that results in a decline in inventories raises price in a competitive market, even if inventories remain positive (Pirrong, 2011). Demand is higher when a high-valuation long appears than when a low-valuation one does; the high-valuation long consumes the commodity delivered to him (and therefore reduces stocks) and the low-valuation one does not (therefore having no impact on stocks). The higher demand represented by the high-valuation long therefore causes prices to increase even if he consumes less than inventories. By misrepresenting himself as a high-value long, a low-value long can therefore cause a supercompetitive price even if the (misrepresented) demand is smaller than inventories, i.e., would not result in a complete depletion of available stocks.

This has implications for the conditions under which a a long can cause a supercompetitive price, i.e., a price that does reflect the true value of the deliverable. Pirrong (1993) shows that if shorts *know* that a manipulating long will resell after taking delivery, the long must have a position in excess of inventories of the deliverable commodity (i.e., a position in excess of "deliverable supply"): that is, to cause an artificial price, the long must corner the market. However, the high-valuation long consumes deliveries, thereby causing the value of the commodity to rise even if he does not consume the entire inventory of the deliverable. Anticipation that this actual consumption may occur causes the price to rise in response to a long offering to sell at $\bar{P}$ even if this increase in consumption is smaller than deliverable inventories. This means that a market power manipulation (i.e., a manipulation involving a long taking an excessive number of deliveries) can succeed in distorting prices even if the large long has *not* fully "cornered" the market by obtaining a position in excess of deliverable supplies.

Thus, uncertainty about a long's valuation for the deliverable commodity can make manipulation possible under circumstances in which it would not be possible absent such uncertainty. The low-valuation long demands a supercompetitive price (a price above the actual value) to liquidate, and shorts are willing to pay this price to liquidate their positions because the possibility that the long is actually going to consume the commodity makes it more valuable, thereby raising the opportunity cost of offsetting short positions through delivery.

Next consider the implications of the analysis for price movements and deliveries. Many of the price effects of market power manipulation by misrepresentation are the same as for a market power manipulation when the long's type is known. The price of the manipulated future is artificially high. Moreover, the manipulation causes the price of the manipulated contract to rise relative to deferred contracts. That is, it causes the forward curve to flatten (spreads to narrow). This is a direct implication of the theory of storage, which implies that a demand shock that results in a decline in inventories causes prices for all delivery dates to increase, with the magnitude of the increase declining with time to expiration.

The previous implication differs from that in a model in which shorts know that the manipulator will sell what is delivered when the manipulation is over (and which requires that the long corner the market to distort prices). Specifically, in the manipulation-by-false-signal model, the deferred futures prices rise, whereas they fall in the corner model in which the long's type is known.

This is another implication of the theory of storage. Under the theory an increase in demand/reduction in inventories causes the entire term structure of futures prices to increase. The amount of increase is decreasing in time to maturity (i.e., the forward curve "flattens" and spreads "narrow") but all futures prices increase nonetheless. In contrast, when it is known that the long will resell, a manipulation increases supplies at the delivery location, which causes the post-manipulation spot price to fall below the no-manipulation competitive price. In the absence of deception, this anticipation of an inflation in supplies at the delivery point after the manipulation causes the prices of deferred contracts (i.e., contracts expiring after the manipulation) to fall.[11]

The model also has implications for post-manipulation prices. Specifically, prices fall when the manipulating long sells what is delivered to him. That is, the lying large long resells the commodity at a price that is lower than he paid for it at delivery, and therefore incurs a loss on deliveries. Thus, as in a corner with no uncertainty about his type, the long incurs a long when he "buries the corpse" of the manipulation.[12]

The model implies that manipulation-by-false-demand-signal is inefficient. Although there are not necessarily distortions in commodity flows (as in a corner), the manipulator takes excessive deliveries which impose deadweight costs–the transactions costs $\tau Q^*$.

[11]This also implies that the futures curve flattens less when the manipulator deceives.

[12]If $\tau$ does not depend on the number of deliveries, the marginal cost of burying the corpse does not depend on the number of deliveries. In contrast, when resale is expected, the marginal cost of burying the corpse (the difference between the price the manipulator sells post-delivery and the no-manipulation competitive price) increases in the number of deliveries. This is another way in which deception enhances the profitability of manipulation.

Furthermore, deliveries are excessive when the long is a strong stopper. When a long values the commodity at $\bar{P}$, the optimal number of deliveries $Q_s$ solves $\bar{P} = MC(Q_s)$. Because $MC(Q) > MC^*(Q)$, $Q_s < Q^*$. When shorts are uncertain about the long's type, they deliver $Q^*$ when the long is a strong stopper, even though this quantity is inefficiently large. Thus, because of the potential for manipulation, deliveries, and the amount of deliveries consumed, are excessive even when a low-value long does *not* manipulate.

Moreover, this form of manipulation adds noise to the futures price, which interferes with its economic purpose of price discovery. Furthermore, it causes the futures price to rise relative to prices at non-delivery locations (because it is a false signal of demand specific to the delivery point). This causes the basis to fall, imposing costs on out-of-position short hedgers.

With a slight modification, the model implies that false-signaling manipulation increases price variability, and therefore reduces the value of the futures contract as a hedging instrument if the presence of a long who offers $\bar{P}$ leads to a decline in the basis. Specifically, consider an extended game in which market participants enter futures positions at time 0. At time 1, a stopper appears with probability $p_s$. This stopper is strong with probability $p_H$, and at time 2 the stopper makes an offer and the game analyzed above plays out.

In this extended game, in the absence of manipulation, assuming risk neutrality (so that the time 0 futures price is the expected price at expiration) the futures price is

$$F_c = (1 - p_s)P_c + p_s[p_H \bar{P} + (1 - p_H)P_c] = P_c(1 - p_s p_H) + p_s p_H \bar{P}$$

and the variance is:

$$\sigma_c^2 = (1 - p_s p_H)(P_c - F_c)^2 + p_s p_H(\bar{P} - F_c)^2$$

With manipulation, the futures price is:

$$F_M = P_c(1 - p_s) + p_s \bar{P}$$

and its variance is:

$$\sigma_M^2 = (1 - p_s)(P_c - F_M)^2 + p_s(\bar{P} - F_M)^2$$

It is straightforward to show that (a) the variances are equal if $p_s = 0$ or $p_s = 1$, (b) $d\sigma_M^2/dp_s > d\sigma_c^2/dp_s$ when $p_s = 0$, (c) $\sigma_M^2$ and $\sigma_c^2$ both achieve a maximum when $p_s = .5$, and at this point, $\sigma_M^2 > \sigma_c^2$, (d) $\sigma_M^2$ and $\sigma_c^2$ are quadratic in $p_s$, and (e) $d^2\sigma_M^2/dp_s^2 < d^2\sigma_c^2/dp_s^2$. Together, these imply that $\sigma_M^2 \geq \sigma_c^2$ for all $p_s$. That is, manipulation raises futures price variance: if the presence of a long who offers $\bar{P}$ reduces the basis, a similar analysis shows that manipulation increases the variance of the basis as well.

Finally, the model is also descriptively accurate in key aspects. Firms capable of delivery (e.g., operators of elevators regular for delivery on Chicago Mercantile Exchange/Chicago Board of Trade grain futures contracts) distinguish between strong stoppers who are likely to consume the commodity delivered to them, and weak stoppers who are unlikely to do so. Moreover, although deliverers do not know for certain whether stoppers are strong or weak, they attempt to estimate the likelihood of stoppers' types. Importantly, they deliver larger quantities when they assess that the stopper is likely to be weak than strong. This has been recognized since at least Hieronymous (1977): "Typically, elevators do not place grain on delivery if they do not expect to recapture it. If the spread between futures is narrow, they may place grain on delivery, expecting that the delivered grain will be redelivered by speculators."

# 5 Summary and Conclusions

The fact that it is efficient for some holders of long futures positions to take delivery and consume what shorts deliver to them creates the opportunity for holders of long futures positions who are *not* efficient consumers of the deliverable commodity to execute a market power manipulation when shorts cannot tell whether or not a long stopping deliveries is an efficient consumer. Market power manipulation is possible when a long faces a downward sloping demand curve for his positions at expiration (during the delivery end game). The fact that a long may consume a commodity, and therefore deplete stocks and bid away the commodity from other consumers causes the demand curve the long faces to slope down. A long who cannot efficiently consume the commodity can exploit this downward sloping demand curve to exercise market power by mimicking an efficient consumer and demanding a high price to liquidate his futures positions.

Crucially, deceit (misrepresentation of demand for the deliverable commodity) can make market power manipulation possible in circumstances in which it would be impossible if shorts knew for certain whether or not a long was an efficient consumer of the delivered commodity. If shorts know a long will not consume the commodity they deliver to him, the long can exercise market power only if his position exceeds inventories in delivery locations (which is the conventional definition of deliverable supply). However, if shorts are uncertain about the type of long, and hence uncertain about whether he will consume the commodity or resell it, a low-valuation long can exercise market power even when his futures position is smaller than inventories in deliverable position.

This has important policy implications because courts and regulators have ruled that a position in excess of deliverable supplies is a *necessary* condition for a long to execute a market power manipulation. The model in this article demonstrates that requiring a position in excess of inventories in deliverable position to sustain a manipulation conviction is unduly restrictive when it is efficient for some longs to take delivery and consume the delivered commodity, and shorts are uncertain about the long's motivation for taking delivery. That is, the quantity of inventory in deliverable position is *not* a sufficient statistic for the slope of the delivery supply curve (and hence for the slope of the liquidation demand curve) when such uncertainty exists.

In other words, in determining whether a large long has market power it may be necessary to determine whether shorts are uncertain about his reasons for taking delivery. When some longs take delivery for efficient reasons, an inefficient consumer can exploit uncertainty merely by standing for delivery, and thereby deceptively signaling that he is an efficient consumer. Further deceptions that increase shorts' estimate of the likelihood that the inefficient consumer is an efficient one enhance the long's market power.

Thus, in manipulation cases, when evaluating whether a large long has the "ability to cause an artificial price" (one of the requirements to sustain a finding of manipulation) courts and regulators may need to take into account the information environment in which shorts operate. In particular, they may need to evaluate whether shorts are uncertain about a long's motives for taking delivery, and whether the long exacerbated this uncertainty through deceptive statements or actions.

An inquiry into the information environment is not necessary in all cases: a long position exceeds inventories in deliverable position is sufficient to demonstrate an ability to exercise market power, and cause an artificial price.[13] However, in cases in which the accused long's position is smaller

[13] Even in cases in which the long has a position in excess of deliverable inventories, the

than deliverable supply, it is incorrect to conclude that he could not have exercised market power without an examination of the information environment, and the long's potential distortion of that information environment through deceptive words or deeds.

In sum, the ability of a large long to execute a market power manipulation depends on the information available to shorts about whether the long is an efficient consumer of the deliverable commodity. If shorts do not know whether the long is an efficient consumer (a strong stopper), an inefficient consumer with a long futures position can exercise market power under conditions in which he could not if shorts knew his type for certain. Furthermore, an inefficient consumer long can enhance his market power through acts or words that increase shorts' estimates of the likelihood that he is actually an efficient consumer.

Deception-enhanced manipulations cause welfare losses, meaning that sheep pretending to be wolves impair the efficient functioning of futures markets. This provides a rationale for deterring such conduct through legal sanctions. Existing precedents–notably definitions of deliverable supply–arguably undermine the deterrence of market power manipulation *via* deception, so courts and regulators should be aware of and sensitive to the role of expectations and information in affecting the ability of a large long to exercise market power.[14]

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information environment and shorts' beliefs may be relevant for other purposes, such as establishing intent and causation (which in the case law is distinct from ability to cause). The analysis demonstrates that deceit enhances market power, and evidence of deceit is therefore probative regarding a long's intent to manipulate. Moreover, acts or statements that lead shorts to believe that a long will take delivery and consume the commodity will cause futures prices to rise and spreads to narrow around the time that these participants observe them.

[14]Section 6(c)(1) of the Commodity Exchange Act, added to the statute by Section

753 of the Dodd-Frank Act, prohibits the use or employment of "any manipulative or deceptive device or contrivance" in U.S. futures and swaps markets. The conduct analyzed in this article could (and arguably should) constitute such a "device or contrivance," but it remains for courts to make such a determination in the context of a specific case.

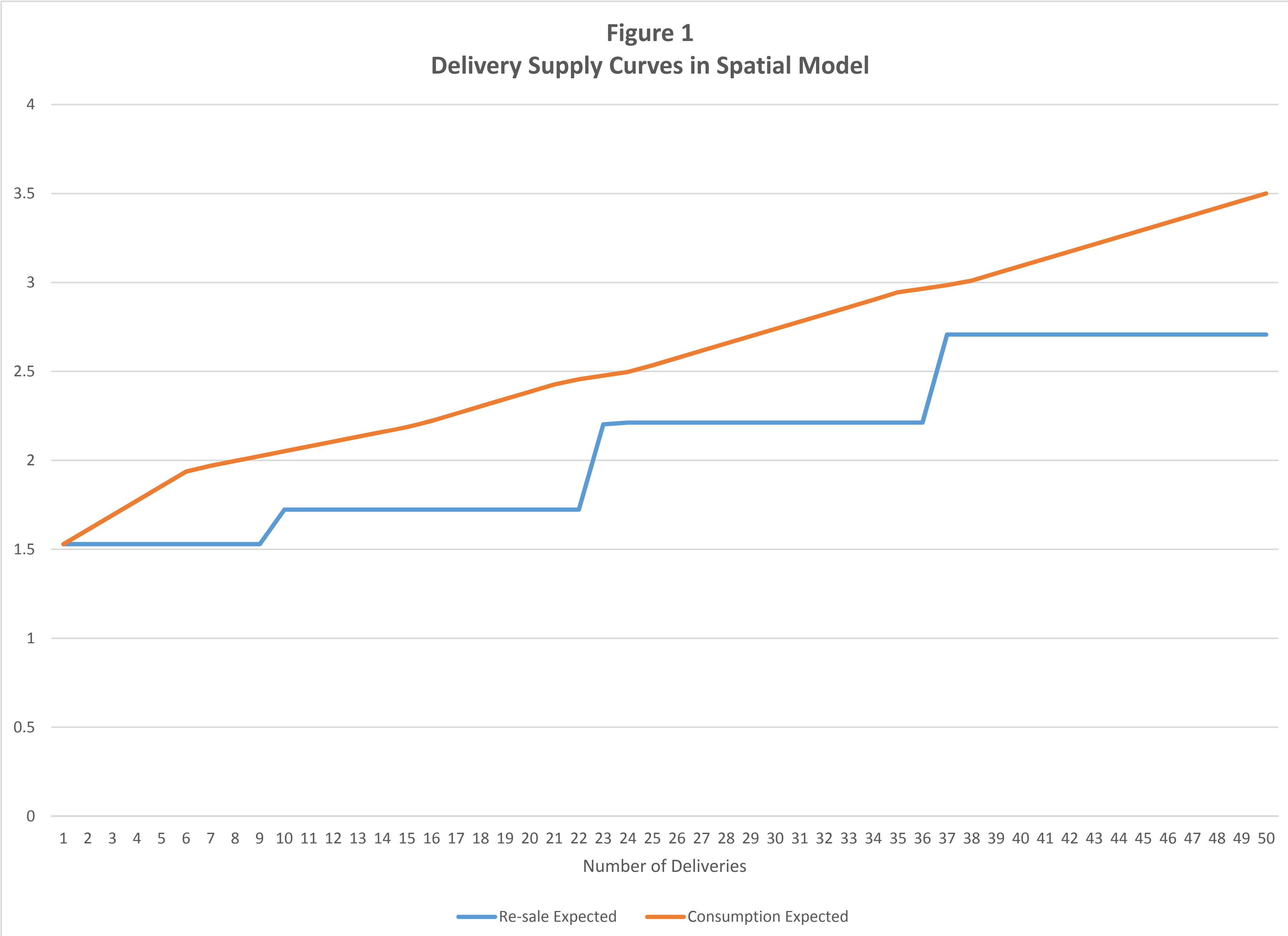


Figure 1
Delivery Supply Curves in Spatial Model
0
0.5
1
1.5
2
2.5
3
3.5
4
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50
Number of Deliveries
Re-sale Expected
Consumption Expected

**Figure 2**

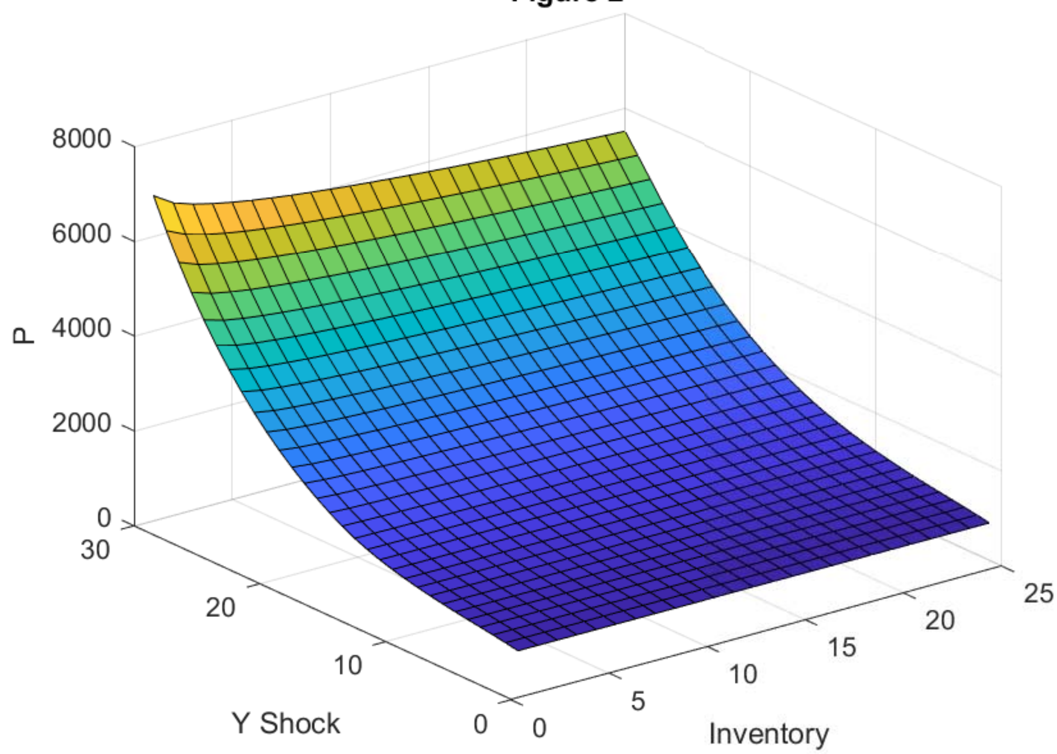
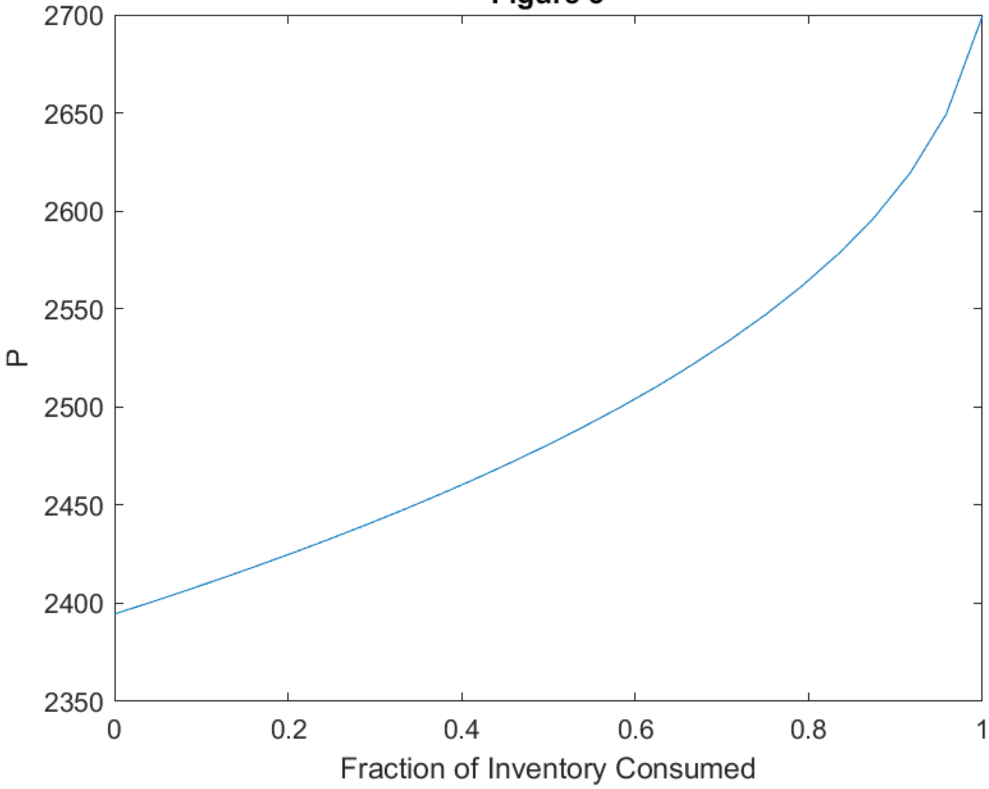

8000
6000
4000
2000
0
P
30
20
10
0
Y Shock
0
5
10
15
20
25
Inventory

Figure 3


2700
2650
2600
2550
2500
2450
2400
2350
P
0
0.2
0.4
0.6
0.8
1
Fraction of Inventory Consumed

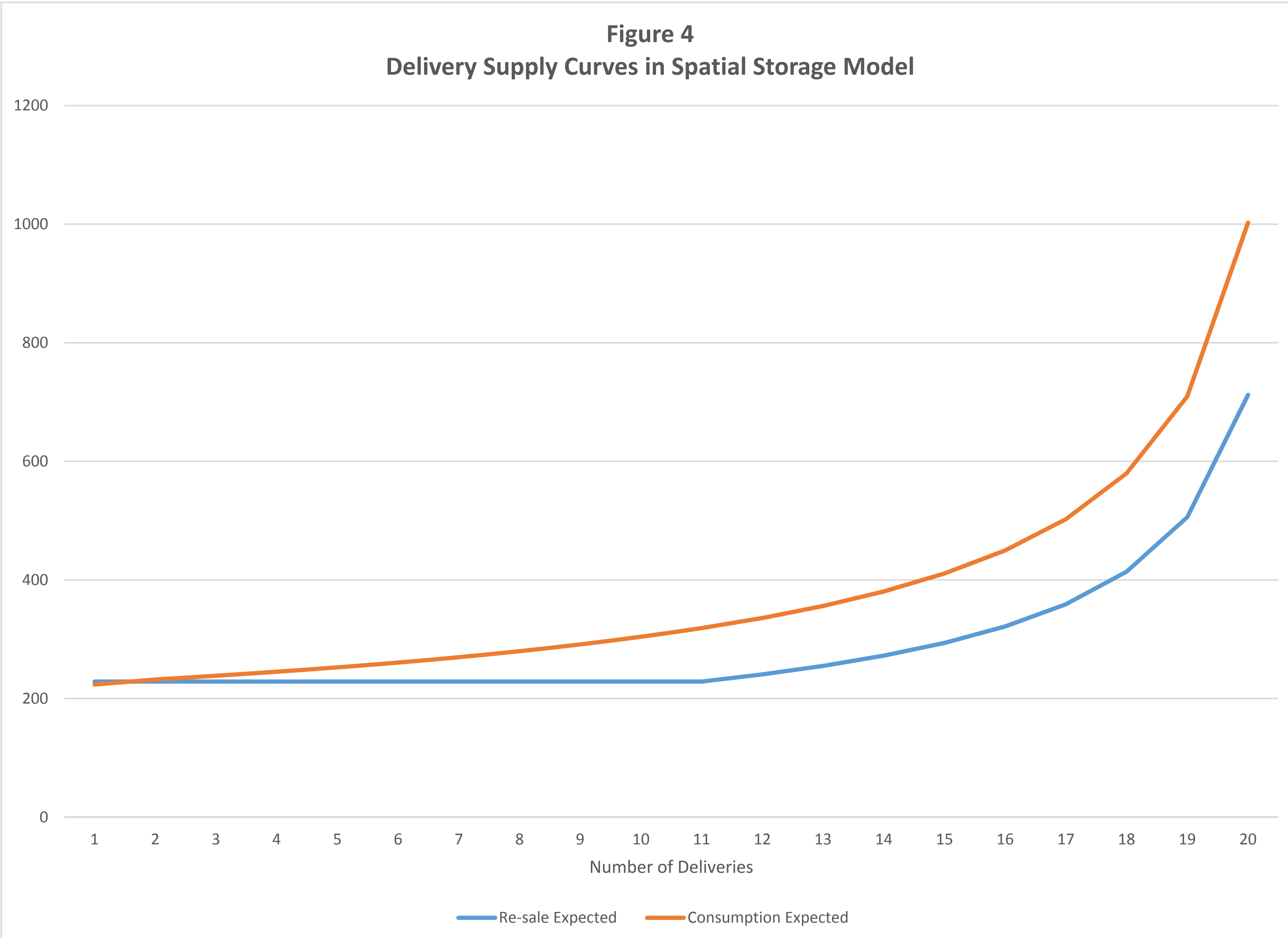


Figure 4
Delivery Supply Curves in Spatial Storage Model
1200
1000
800
600
400
200
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Number of Deliveries
Re-sale Expected
Consumption Expected