The Inconvenience Cost: A Portfolio Approach to Non-Convergence Between Cash and Futures Prices

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The Inconvenience Cost: A Portfolio Theory Approach to Non-Convergence Between Cash and Futures Prices

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Why haven’t prices converged?
Cash and futures prices for storable commodities should reach equality, or converge, upon contract maturity. Traders can impose convergence during the delivery month through arbitrage behavior, either making or taking delivery on futures contracts. If convergence is not predictable, a futures market fails to provide a clear storage signal to potential inventory holders and reduces the attractiveness of hedging [3], which can threaten its own viability [2]. Recent convergence problems in domestic commodity markets [3] demonstrate the existence of persistent, significant arbitrage opportunities over the second-half of the last decade. Yet, terminal elevator operators—perhaps the only participants with the capacity to do so [4]—have not arbitrag ed away these residual returns by making enough deliveries.

This model demonstrates conditions under which a profit-maximizing warehouseman foregoes available arbitrage. We find that making delivery involves substantial opportunity costs [4], which stem from the loss of managerial control over warehouse space. We refer to the inconvenience of losing such control as the inconvenience cost.

Figure 1: Arbitrage Opportunities for CBOT Wheat: Run off the First Delivery Day in Chicago

The elevator operator’s portfolio
A terminal elevator operator allocates his available warehouse space (h) between making delivery (f) and other business (g).

Making delivery carries a riskless return (rf) but the operator loses control of the space he allocates to this behavior [4], since the take of the delivery instrument is a passive trader, and earns only a storage fee over the period. The risk-free return is a combination of the arbitrage from the delivery-month basis (b) and storage fees (D).

Warehouse space can also be allocated to alternative business, such as providing throughput to regular turnover customers, storing this or some other commodity (g) whether hedged or unhedged, or a combination of these, to earn a risk return (r) with some variance (σ²).

The total expected return for the portfolio (rf) is a linear combination of the expected returns of delivery and the alternative, weighted by the relative allocation of available warehouse space plus an adjustment for any risk aversion (α):

\[ U_f = f \cdot r_f + g \cdot r_g - \frac{1}{2} \cdot \sigma_f^2 \]

When does an elevator force convergence?
Portfolio utility now includes the arbitrage surplus, p(0), from a strengthening basis:

\[ U_f = f \cdot r_f + g \cdot r_g - \frac{1}{2} \cdot \sigma_f^2 + p(0) \]

A risk-neutral elevator operator will choose to deliver until the arbitrage return is equal to the risk-adjusted alternative return. Risk aversion makes delivery more attractive. The optimal delivery allocation is now:

\[ f^* = \frac{\gamma - \frac{\sigma_f^2}{2}}{\sigma_f^2} - D \]

A risk-averse elevator will choose to deliver only if the arbitrage return is higher. Futures and cash prices will:

• Converge if D=0
• Not converge otherwise

Figure 4: Convergence Conditions

Conclusion
The possibility of arbitrage does not necessarily lead to convergence, even without accounting for grade and location differences in the commodity.

The opportunity cost of making delivery, or the inconvenience cost, entails a loss of control of warehouse space, and may be too high for the elevator operator to arbitrage away non-convergence.

Although risk aversion may lead to more deliveries, convergence is still dependent upon opportunity costs.

An endogenous basis
Re-specify the return as the delivery-month basis as an linear function of the arbitrage behavior by the warehouse:

\[ b = h - Df \]

If the elevator operator delivers enough, he will force the basis to zero and impose convergence, assuming QED.

Figure 3: Endogenous Basis

References

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For further information
Please contact Michael Adjemian at madjemian@ers.usda.gov. More information on this and related projects can be obtained at https://ers.usda.gov.

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