# Options and Limits to Arbitrage

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# Why?

The departures from the standard Black and Scholes model are material.

One approach is to search for a process and its equivalent martingale measure version that reconciles the data to the model. Such a model will probably also require time-varying risk premia.

An alternative (and not mutually exclusive) approach is to consider the effects of "limits to arbitrage" on option prices.

# Limits to Arbitrage

Limits to agents' ability to take advantage of "optical arbitrages" arise from market frictions. In fact, the 2007 liquidity crisis cast limits to arbitrage in the spot light.

As an example, consider coupon spreads. Why do recently-issued 10-year notes sell at a higher price than a replicating portfolio of coupon strips?

Shorting an asset in practice a not quite as simple as in the text book arbitrage examples.

An asset that has a high demand to short can afford its owner a convenience yield in the form of repo specialness.

At the same time repo specialness makes it more costly to short the asset.

# Bollen & Whaley

Bollen and Whaley (2004) add put some new facts on the table:

1. S&P 500 Index Options:
   1.1 Pre-1987 implied volatilities smiled.
   1.2 Post-87 crash implied volatilities decline monotonically in call strikes.
   1.3 Most trading in index options involves puts.
2. Individual stock Options:
   2.1 Implied vols are more negatively sloped (in call strikes) than for the index.

# Bollen & Whaley 2.

BW find that changes in the level of an option's IV are positively related to time variation in demand for that option. They consider returns to delta-neutral positions that write options.

> *Results support the hypothesis that the IVF reflects a series of supply and demand equilibria. . . . –Net buying pressure plays an important role in determining the shape of the IVFs, particularly for options on the S&P 500 index where public order imbalances are greatest.*

They contrast their results with Dennis and Mayhew (2002) who find no such relationship. They claim that this is because the latter use volume to measure buying pressure (which is too imprecise).

# Gârleanu, Pedersen, & Poteshman

In their 2009 *RFS* paper, Gârleanu, Pedersen, & Poteshman build a model where option market makers face unhedgeable risk – which can manifest in prices. Examples of such risks include:

- Inability to hedge continuously.
- Jumps in the price of the underlying asset's price.
- Stochastic volatility risk.

They measure net option demand as long open interest minus short open interest for public customers and firm proprietary traders (the negative of market-maker net demand).

# Gârleanu, Pedersen, & Poteshman 2

- They use daily data from 1996 through 2001. Ivy database from Option Metrics provides the implied vols.
- They find that options with high end-user demand are more highly priced. For example, index options are expensive and have high net demand.
- By contrast, (individual) equity options have small negative end-user demand, and these are not expensive.
- Re: Bollen and Whaley (2004): "they set the stage by showing that *changes* is option demand lead to *changes* in option prices, ... [We show that] the *level* of option demand impacts the overall *level* of option prices or the overall shape of implied volatility curves."

# Evans, Geczy, Musto, & Reed

- Data are: (Repo) rebate rates, fails, and buy-ins from an options market maker for 1998 and 1999. (Buy-in means that the recipient of the shares sold short forces delievery on some or all shares in the dealer's short position.
- 91% of shares entailed general collateral rate and 9% on special. EGMR find that in one-half of the cases where the share trade on special, the market maker fails to deliver at least part of the position. Failing is especially prevalent when rebate rates hit 0.
- Note that REG SHO (effective January 2005) eliminates the special privilege for dealers to not deliver sales in a short position (known as "naked shorting").
- EGMR measure the effect of short-selling costs on options prices using put-call parity.
- The costs of shorting manifest in violations of put-call parity – kink at 0.

# Evans, Geczy, Musto, & Reed 2

- Define deviation from put-call parity: $\Delta_{j,t} = \frac{S_{j,t} - S^i_{j,t}}{S_{j,t}}$.
- Regress $\Delta_{j,t}$ on contemporaneous specialness, moneyness and term. All 3 coefficients are positive and statistically significant.
- When they add a term that interacts specialness with an indicator variable equal to 1 when the rebate rate is negative, this has a significant negative coefficient.
- Note that multiple listing started in August 1999. Some evidence that this inccrease in dealer competition reduces the put-call parity deviations induced by specialness.

# Price Pressure

- As Gromb and Vayanos (2010) note, an interesting aspect of these examples, "is that arbitrageurs transmit shocks to the demand for one asset to other assets, with the effects being largest for assets that covary the most with the original asset."
- Fundamentally, GPP and EGMR have the options order flow moving the price. But they do not look explicitly at price pressure. Curiously, Vijh (1990) finds no price pressure in the options markets – but very wide spreads.
- I'm a little confused on how maximum spread restrictions work and/or are applied. EGMR (p. 1971) reference SEC Rule 1014(c)(i)(A) –but this is actually a FINRA (formerly NASD) rule.
- No reason to throw away microstructure theory. But an important issue is whether there is price discovery in options (in which case options market makers are subject to adverse selection risk).