

OPTION PRICING THEORY AND ITS UNINTENDED CONSEQUENCES

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Scientific breakthroughs often give rise to unintended consequences. For example, atomic theory enabled the wonders of nuclear energy, but also gave birth to the atom bomb. I couldn't help but think of this analogy when the Nobel Prize in Economic Sciences was awarded last year to Myron S. Scholes and Robert C. Merton for their work on option pricing theory.

Scholes and Merton, together with the late Fischer Black, solved the problem of option pricing by examining the essentially risk-free nature of a hedged option position.¹ An option plus some continuously adjusted offsetting position in the risky asset underlying the option will yield a riskless rate of return. This in turn implies the equivalence, at least in theory, between options and dynamic positions in the underlying risky asset and a risk-free asset. The price of an option must thus equal the price of its replicating portfolio; otherwise, an arbitrage opportunity would exist.

The publication of the option pricing formula in 1973 coincided with the establishment of the first listed options markets in the U.S. The former allowed investors to value options more accurately

than ever before, while the latter enabled them to trade options more readily. Together, these developments fostered the growth of a booming industry that provides investors with new tools for controlling risk and enhancing return.

Options per se and the pricing formula itself are valuable and benign. However, the replicating portfolios implicit in the pricing formula opened the door to the creation of *synthetic* options. Not only can investors use the theoretical replicating portfolio to price its corresponding option, but, by taking and trading positions in the underlying asset and a risk-free asset, investors can construct an actual portfolio that synthesizes the behavior of a desired option.² Such synthetic options, because of the way in which their trading demands can amplify market moves, may pose a grave danger to market stability.

To see why this is so, consider the trading activities of option market-makers and OTC option dealers. They stand ready to meet the demands of investors by providing desired options, for a price. Whenever they sell options (either puts or calls), however, they expose themselves to unlimited market risk. They will try to lay off this risk as

quickly as possible. Ideally, they will be able to find a speculator to whom they can turn over the short option positions they have assumed; they “close out” their short positions by buying equivalent long option positions from the speculator, who is willing to take on the risk from uncertain market volatility in exchange for the certain income from an option premium.

Unfortunately, market-makers and dealers may not always (or even usually) be able to hedge their short positions by buying other options. First, OTC dealers who have sold tailored options with specifications unavailable in listed markets may find they cannot replicate an offsetting position using exchange-traded options. Second, dealers and market-makers may find buying options is uneconomical in market environments in which the public displays a marked preference for buying over selling. This may often be the case, as investors seek protection from market declines or seek a means of participating in market gains.

When they cannot find natural partners to take on their short positions, option dealers and market-makers may have to turn to the equity futures and, possibly, stock markets, synthetically replicating long option positions to hedge the option positions they are short. Replicating long option positions requires selling as the market falls and buying as it rises. Such trend-following trading can exacerbate price movements. It constitutes positive feedback, which is inherently destabilizing.³

For example, when the dynamic hedging required by long option replication calls for buying, it can cause prices to rise more than they otherwise would. Prices can rise above the levels supportable by fundamentals. The higher prices rise above fundamental values, the more fragile the market becomes. At some point, even slightly bad news can trigger a price decline. At this point, the same dynamic hedging rules that required buying on the way up will require selling on the way down.

Replication trades alone have the potential to exacerbate price moves. Moreover, other investors, unaware that replicators’ trading rules are mechanistic and informationless, may misread the trades as containing information about fundamentals. These investors may be encouraged to trade in the same direction as, or discouraged from taking the other side of, replicators’ trades. Thus trend-following dynamic hedging trades can set off a “snowball effect” that magnifies the impact of hedgers alone. And, given investors’ tendencies to be more averse to

losses than desirous of gains, panic selling is likely to be more pronounced than manic buying.

By demanding more liquidity than the market is able, or willing, to provide, option replication may create a liquidity crisis. If concentrated selling by option-replicating dynamic hedgers causes market prices to gap down, the very viability of option replication becomes problematic. Replication assumes the ability to transact at continuous prices. In the presence of price discontinuities, hedgers may not be able to execute trades at the required prices. The dynamic hedge may fail to offer the protection it was designed to provide. Worse, a market crash can ensue.

Is there any evidence to indicate that trading associated with option replication has actually destabilized equity markets? Well, similar trend-following trading has played havoc with investors in the past.

In the 1920s, for example, margin buying fed a huge market run-up; as speculation inflated share prices, margined investors flush with additional collateral borrowed more and bought more, driving prices up further. When prices began to decline, however, margin calls forced investors to liquidate stock, taking the market down. After the Great Crash of October 1929, the market bounced back fairly readily, only to succumb, in the early 1930s, to misguided policy efforts that paved the way to the Great Depression.

In the 1980s, option replication itself had much the same effect on markets. By the early fall of 1987, portfolio insurance vendors had sold what amounted to a massive synthetic put on the entire stock market. Portfolio insurance strategies covered up to \$100 billion in equity assets, or 3% of the market’s capitalization at the time. Portfolio insurance was option replication; it aimed to provide for institutional-size portfolios the protection that would have been provided by listed portfolio puts, had they been available.

Institutional investors were drawn to portfolio insurance for a number of reasons. It offered them a way to lock in the substantial gains the equity market had made since 1982. It promised a “guaranteed” floor return. This apparent safety net in turn seemed to grant investors the leeway to increase their risky equity exposures. Portfolio insurance exploited investors’ human frailties and insecurities by promising increased returns at reduced risk. What’s more, it appeared to be cheap, a bargain: Because it was not a real option, it required no payment of an option premium.

In reality, portfolio insurance proved a bad bargain. Its automated purchases helped fuel the market's rise in the mid 1980s. But when the market began to fall in October 1987, portfolio insurers had to sell. Their sales depressed prices further, and set off a snowball effect. Some savvy investors front-ran insurers, attempting to lock in prices before insurance sales drove them lower. Other investors, unaware that insurance sales were informationless (that they merely reflected replication trading rules), were frightened into selling alongside insurers, or scared away from taking the other side of insurance trades.

Portfolio insurers' option-replicating sales soon turned a market correction into a liquidity crisis, and into the worst single-day loss in U.S. market history. That 23% decline in turn trampled on the "guarantees" of most portfolio insurance programs. But while investors deserted portfolio insurance in droves in the wake of the crash, dynamic hedging in pursuit of option replication continued to thrive.

Dynamic hedging associated with OTC puts was blamed for several bouts of more recent market instability — notably in October 1989 and November 1991. (Note that these market "breaks" occurred despite the improvements to market infrastructure and the imposition of circuit breakers since the crash of 1987.) These episodes, together with the October 1987 Crash and precursor "events" in September 1986 and January 1987, cohere in a pattern characteristic of U.S. equity markets in the 1980s and 1990s — one of broad trending behavior interrupted by infrequent but large downdrafts followed by fairly rapid recoveries. This is consistent with a market subject to mechanistic, trading-rule-induced breaks.⁴

The continued advance in equity market prices since 1991, together with the market's current volatility, with the Dow rising by hundreds of points on one day and falling by hundreds on another, have if anything increased the demand for OTC options, for an expanded menu of listed options, and for retail products promising equity participation with guaranteed protection of initial investment. According to the Bank for International Settlements, U.S. OTC equity index options alone added up to some \$107

billion in notional value at the end of March 1995. Assuming this OTC market has grown by as much as the market for listed equity index options (and it is more likely to have grown a great deal faster), there would be about \$200 billion notional value in OTC equity index options in the U.S. today.

How much long-option replication is associated with an OTC market of this size? And what of the hedging demands of exchange market-makers? Are the demands great enough to pose a threat to market stability? Given the current state of disclosure, especially regarding OTC option markets, it's difficult to say. But if history is any guide, it tells us that levels of trend-following dynamic hedging that may seem very small in relation to the overall market can have outsized effects.

Options can be wonderful instruments for controlling risk. But risk is an unavoidable part of financial markets in the aggregate. Risk can be shifted, but it can't be eliminated. We forget this at our peril. Attempts to avoid risk using option replication can ironically end up creating more risk, and courting disaster.

ENDNOTES

¹See Black and Scholes [1973] and Merton [1973].

²See, for example, Rubinstein and Leland [1981].

³In contrast, short-option replication, and much value investing, requires buying as the market falls and selling as it rises; this is negative feedback trading, which is stabilizing.

⁴That option-replicating dynamic hedges have not led to an increase in the measured volatility of the underlying equity market is undoubtedly owing to the remarkably steady growth of the U.S. economy since the early 1980s, as well as the trend-reinforcing nature of such strategies.

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