The Economic Functions of Derivatives: An Academician's Point of View

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David Pyle
Haas School of Business
University of California at Berkeley

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Abstract

The question of the economic functions of derivatives has been widely discussed in the financial economics literature. In this paper, I focus on the sources of economic efficiency gains from the use of derivatives. These sources include helping to complete capital markets, lowering transaction costs, and reducing agency costs. Many of these functions can be obtained by using primary securities as an important question is what characteristics of derivatives account for their enhanced efficiency and utility relative to the assets that underlie them. Three characteristics are identified and discussed: 1) the dependence of derivative value on changes in the value of underlying assets, 2) the positive dependence of some derivative values on asset volatility, and 3) the non-linear payoffs provided by some derivatives.
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My assignment at this conference is to present an academic perspective on the economic functions of derivatives. As you undoubtedly know, there are about as many viewpoints on the motivations for financial innovation, including the introduction of derivatives, as there are academics who have addressed the topic. The emphasis of my talk today will be on the characteristics of derivatives that distinguish them from other financial innovations.

It is important to begin with a clear understanding of what is meant by the term "derivatives". This is addressed in a short prologue. The two main sections of the paper contain a discussion of the major economic functions of derivatives. Finally, I will draw an implication for regulators from that discussion.
What Are Derivatives?

Rubinstein (1987) made a distinction between derivative assets (assets whose payoffs are completely determined by the prices or payoffs of other underlying assets) and a more comprehensive asset class, contingent claims, (assets, including derivatives, whose payoffs are determined by a predefined set of underlying variables). Accordingly, a government bond future falls into both asset classes, while an inflation future is a contingent claim, but not a derivative asset. This distinction is useful in some contexts, but it has not been adopted by market players nor by the financial press. Occasionally, index mutual funds, basket securities, and other assets that are portfolios of primary assets are identified as derivatives, but this is too broad a definition for my purposes. Consequently, in what follows, the term "derivative" means an asset whose payoffs are determined by a predefined set of underlying variables.

Economic Functions of Derivatives

Academic scholars have advanced various reasons for the recent
growth in derivatives and other new financial instruments. Their reasons include such diverse functions as the enrichment of securities firms, regulatory and tax avoidance, and economic efficiency gains. The discussion that follows is centered on the sources of economic gains.

Capital markets are central to the flow of savings from households to firms which use the capital infusions to make real investments and return the earnings of those investments to households for consumption or reinvestment. Well-functioning capital markets accommodate this separation between real investment by firms and the provision of financial capital for that investment. Capital markets also provide households and their agents (hereafter, "financial investors") with the ability to choose the return-risk profiles they prefer, and real investors (hereafter, "firms") with financing to meet their specific, sometimes complex needs. Derivatives are useful to both sides of this savings-real investment link.

Merton (1992) identified three ways in which innovative financial products improve economic performance. They can help "complete the market" or lower transaction costs (broadly conceived) or reduce "agency
costs.” The ability to accomplish a specific economic function is not always unique to derivatives. Consider the recent introduction of a "semi-open" index fund based on the IFC’s Investable Emerging Markets Index. The capital of this fund will be invested in 650 shares traded on stock markets in 18 developing countries. This innovation should improve the efficient investment frontier for institutional investors wishing to follow a passive, international investment strategy. A similar increase in "market completeness" could have been accomplished by introducing a futures contract based on the IFC index or, as discussed later, by starting an equity swap fund. Risk sharing, risk pooling, and hedging (e.g. foreign exchange hedging or international diversification) are other examples of economic functions that can be carried out with primary securities as well as with futures and other derivatives. Index and basket securities, whether primary or derivative, serve to reduce transaction costs by permitting portfolio shifts between diversified portfolios and cash using one transaction instead of many. Furthermore, by enabling trades that are "information neutral" and thus reducing the informational concerns of counter-parties, transactions in index and basket securities can also be carried out at lower bid-ask spreads than transactions in individual securities.
Given this scope for achieving various economic functions with either primary or derivative securities, what characteristics of derivatives account for their enhanced efficiency and utility relative to the underlying assets?

First, the value of a derivative is based on changes in the value of underlying assets, not on their full value. For example, futures values reflect changes in the value of the underlying asset from the contract price. This permits capital and transactions efficiency in using these derivatives rather than primary assets for hedging, since derivative margins can be based on anticipated changes in the value of the position while mark-to-market rules and contract design help control default risk and limit margin requirements. Selling an interest rate future typically involves lower transaction costs and less capital investment than the functionally equivalent position in cash plus a short sale of the underlying bond. There is a trade-off between the lower capital investment in the futures and default risk which is offset, at least in part, by the daily settlement of futures contracts. The classic example of a derivative substitution with substantially less default risk than the equivalent primary security position is the use of currency swaps instead of parallel loan agreements.
The Investable Emerging Markets Index Fund mentioned earlier provides a particularly rich example of how the differential payoff characteristic of a derivative allows investors to improve upon a position in the underlying asset. Suppose that, instead of investing in the emerging market shares, the index fund held a portfolio of cross-border swaps. The payoff on each swap would be based on the difference between the return on an index of a developing country's shares and the return on an index of the home country's shares. Swap portfolio weights would be selected to match the weights in the IFC's Index. By avoiding direct investment in the shares on emerging markets, this contract would be an improvement on the emerging markets mutual fund in a number of valuable ways. Market index swaps, involving no exchange of principal, would reduce the foreign investor's exposure to currency risk, to default or expropriation, and to investment limits introduced to preclude corporate governance and other foreign direct investment conflicts. The swap-based fund would serve many of the same home country economic functions met by the asset-based fund and in addition, would provide international diversification opportunities for shareowners in the developing countries.
A second important characteristic of derivatives but not of primary securities is the positive dependence of derivative value, specifically option values, on the volatility of the underlying asset. It is widely recognized that providing managers with equity claims on the firm in the form of stock ownership or stock options may be used to solve agency problems by motivating managers in ways that are in the interest of shareholders. For stock options, however, a more subtle consideration also applies. Managers tend to be poorly diversified. In many cases, the value of their human capital is strongly tied to the welfare of the firm. Stock ownership further exacerbates this mal-diversification and, if the manager is risk-averse, he may unduly avoid risk by not accepting riskier, positive net present value projects. Due to the positive risk-taking incentive adhering to options, shareholders can encourage such managers to undertake more risk by awarding them call options.

As another example of the economic value resulting from the sensitivity of option values to underlying asset volatility, note that implied asset volatilities can be estimated from option prices using an appropriate option valuation model. This produces economically relevant information
that otherwise would not be available. Access to these "market" volatility estimates expands the range of economic choices: speculators are able to exploit volatility estimates that differ from implied volatilities, hedges have added information on the risk of their basic asset positions, and regulators have better information on the risks of regulated portfolios. Swiss Bank Corporation's derivative-based technique for evaluating underwriting fees in rights offerings is an intriguing example of this use of derivatives. In the SBC analysis, the underwriter's position is modelled as a combination of a put option sold to the issuing firm and a call option issued to investors.

Employing data from the traded options of the issuing firm, SBC analysts estimate volatilities and use those estimates to price the risk in the underwriter's dual option position. Interestingly, in the two cases reported, the SBC derivative-based estimates of the underwriter fee were substantially below those actually charged in the deals.

Finally, some derivatives, most notably options, provide payoff functions that are non-linear in the payoff of the underlying asset and thereby offer investment and risk adjustment opportunities that cannot be obtained through static investments in the underlying assets. The issue is
whether these "non-linear derivatives" perform real economic functions or are merely zero sum games with no redeeming social value. As we shall see, a fundamental function of non-linear derivatives is to allow investors with atypical characteristics, in terms of endowments, risk tolerance, and asset return beliefs, to obtain investment portfolios that increase their welfare. These functions of non-linear derivatives are the subject of the next section of this paper.

Non-Linear Derivatives and Financial Investors

In the standard economic model of financial investment decisions under uncertainty, primary savers maximize expected utility of wealth, subject to a wealth constraint. The critical elements in this maximization are the investor's wealth endowment, the form of his utility function, and his subjective distribution of the joint returns on the available assets. In the absence of derivatives, primary savers choose portfolios of the available primary securities. By accommodating heterogeneity in endowments, risk tolerance, and expectations, non-linear derivatives can improve savers' expected utility in ways that other derivatives and primary securities cannot.
These functions of non-linear derivatives can be illustrated in the context of an economy in which a risk asset/cash separation holds and a representative or "average" investor exists. The capital market equilibrium in this economy calls for the average investor to hold the market portfolio of primary securities. It follows that the average investor will not hold derivatives that are in net zero supply (i.e. those that net out when aggregated across all investors). On the other hand, investors with atypical endowments, for example the owner of an oil well, will find it helpful to use derivatives to hedge his base risk position. For example, if this ownership position resulted in income flows that were overly dependent on oil prices (i.e. more dependent than the cash flows from the market portfolio), a utility maximizing investor could use non-linear derivatives, such as average price oil futures or average price oil options, to hedge his position.

A demand for non-linear derivatives by rational investors can also be created by differences in investor risk tolerance. Using standard investment theory, we know that an investor with average asset return beliefs and endowments, but above average risk tolerance wants to hold a portfolio with
higher volatility than the market portfolio. This demand can be satisfied in a number of ways: by levering the market portfolio, by holding a market index future, or by holding a call on the index future. In the absence of a transaction cost advantage for the option, this difference in the investor’s level of risk tolerance does not produce a rational demand for a non-linear derivative. However, Leland (1980) showed that a financial investor with average expectations will buy (sell) call options if his risk tolerance increases with wealth more (less) rapidly than average. Holding expectations and endowments constant, the demand for non-linear derivatives is determined by the rate of change and not the level of risk tolerance.

Leland’s 1980 results demonstrate that differences in risk tolerance imply a rational demand for ordinary options. However, an analysis based on risk tolerance does not provide a basis for rational investors to hold path-dependent, non-linear derivatives, such as average price or lookback derivatives. To obtain further insights, Leland (1993) examined the role of investor beliefs in creating derivative demand. Holding endowments and risk tolerance at the level of the average investor, what types of investor beliefs induce optimal holdings of non-linear derivatives? The answers to
this question may be expressed in terms of two descriptors of investor beliefs: the behavior of mean asset return with respect to price (i.e. at a given future date, how does the expected return on the underlying asset vary with its price level?) and the behavior of mean asset return with respect to time (i.e. from a time zero perspective, how does the mean asset return across all feasible price events vary over future dates).\textsuperscript{15} Leland showed that a risk averse investor with average endowments and average risk tolerance will rationally purchase a non-linear derivative based on a given asset if his beliefs concerning that asset differ systematically from those of the average investor.\textsuperscript{16} Specifically, an investor will hold:

a) an \textit{ordinary option} if he believes the asset's mean return increases with price, but is constant through time,

b) an \textit{average price future} if he believes the asset's mean return is invariant to price, but decreases through time,

c) an \textit{average price option} if he believes the asset's mean return increases with price, but decreases through time, and

d) a \textit{lookback option} if he believes the asset's mean return increases with both price and time.

Rational investors with the opposite beliefs would sell these non-linear derivatives. Using Leland's methods, similar statements of payoff-consistent beliefs can be generated for any non-linear derivative.
An Implication for Regulators

Last year, a prominent banking supervisor suggested that derivative houses "...should be able to explain [to generalist supervisors] in simple understandable terms what is the economic and financial benefit of what [they] are doing... what the risks are, and how they can be measured, priced, and controlled..." Financial regulators and supervisors are properly concerned with the effects of derivatives risk on the stability of financial intermediaries. The role of regulators in gauging the economic benefits of derivatives is less apparent. As the preceding discussion suggests, the economic functions of derivatives are many and varied. Some functions, especially those associated with "exotics", have subtle motivations that may be more instinctive to derivative market participants than readily explained by them.

From a free market economist's view, the fact that two informed parties voluntarily engage in these zero sum trades is a demonstration of their usefulness. Why should regulators limit the options, however exotic, of consenting adults? Perhaps less regulatory attention could be given to
prejudging the economic benefits of new financial products and more to the collection and dissemination of data that would help inform derivative market participants.  

It is also dangerous to suggest that regulators and supervisors can be allowed to be at an information disadvantage with respect to the risk and value of derivative positions (e.g. by depending on the regulated to tell the regulator what the risks are). The failure of U.S. Saving & Loan regulators to understand the derivative positions taken by Franklin Savings & Loan is a cautionary case in point. As you may recall, Franklin was declared insolvent while holding a sizable portfolio of mortgage-backed derivatives. Franklin's management claimed the closure was inappropriate, that the firm was and would have remained solvent as long as the derivative positions could be properly managed. Either way, S&L regulators must be considered inept. They either failed to understand the risks inherent in the derivative portfolio they allowed Franklin to acquire or they failed to understand the true value of a properly managed derivatives portfolio at the time of closure or, as is most likely, both of the above.

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In other words, given the pace and scope of financial innovation, the term "generalist supervisor" is an anachronism. Hu(1993) has proposed a solution to the "regulator knowledge gap", one that involves having regulators retain private, third-party derivative expertise funded by market user fees. From an academician's point of view, this financial economist full-employment proposal is an unusually attractive topic on which to close.
REFERENCES


Leland, H.E., "Expectations and Options," Lecture Notes, University of California, Berkeley (May 1993).


13 As noted in the previous section of this paper, options and other derivatives can improve savers' utility by offering lower transaction costs or access to returns on securities or indices not available in capital markets to which the saver has access. These valuable functions of derivatives do not depend on non-linearity in payoffs.


15 Decisions on whether to hold call or put options will, of course, depend on whether investor expectations are optimistic or pessimistic.

16 In his analysis, Leland assumed that the average investor believes the mean asset return is invariant to both price and time. If asset pricing were to reflect average investor beliefs that were not invariant to price or time, the statements regarding atypical investor beliefs would be relative to those average beliefs, e.g. "asset mean return is more price variant than average."


18 For example, information such as the market net worth of derivative suppliers, the outstanding volumes of synthetic derivatives, and detailed price behavior data on underlying assets.
ENDNOTES

* The author is Booth Professor of Banking and Finance (emeritus) in the Haas School of Business, University of California, Berkeley. Robert Einzig and Hayne Leland provided helpful comments on earlier drafts of this paper.

1 Important and differing commentaries on recent financial innovations, including derivatives, are found in Merton (1992), Miller (1986,1992) and Van Horne (1985).

2 For example, one might want to distinguish between contingent claims for which there can be an exact replication strategy and those for which exact replication is not possible. Rubinstein's terminology allows this distinction.

3 Investors may enter or leave the fund at net asset value once per month.

4 See Grauer and Hakansson (1987).

5 Of course, when derivative replication strategies are possible, primary securities may be involved in providing for the same functions as the derivatives themselves.

6 See Merton (1992) p. 14-16 for a full description of this hypothetical swap and for the original statement of the benefits of the swap compared to direct investment in the emerging market.

7 The word 'investable' in the name of the IFC's Index seems to reflect the fact that it is composed only of those stocks foreigners are permitted to buy in the 18 countries represented.

8 Swaps would not provide new private financial capital flows for real investment in the developing countries and that may be one of the major reasons for the introduction of the IFC fund.

9 See Bhagat, et.al (1985).

10 See Reitman (1993) for a demonstration of the role of non-linear derivatives in overcoming a tendency for some managers to engage in overly aggressive competition to the detriment of shareholders.

11 Reported in the Financial Times, June 1, 1993.

12 The contents of this section of the paper draw heavily on works by Hayne Leland (1980,1993) to whom I am also grateful for helpful discussions of this topic.