

For a call option

$$C(x_t, t; K) = e^{-r(T-t)} \int_K^\infty (x_T - K) \hat{\pi}(x_T | x_t) dx_T.$$

Differentiating twice with respect to the strike price K gives

$$\frac{\partial C(x_t, t; K)}{\partial K} = -e^{-r(T-t)} \int_K^\infty \hat{\pi}(x_T | x_t) dx$$

$$\frac{\partial^2 C(x_t, t; K)}{\partial K^2} = e^{-r(T-t)} \hat{\pi}(K | x_t). \quad (9)$$

Hence the value of any derivative product can be determined using the linear pricing operator derived from the value of options on the basis asset.

CONCLUSION. Derivative products now dominate the financial markets. In many cases the volume and liquidity in the derivative market exceed those in the corresponding cash market. Certainly part of the success of the derivative market is due to the traders' ability to price the range of available contracts reliably and quickly. The valuation of derivative products will probably continue to play an important role in their development.

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See also ARBITRAGE; CONTINGENT CLAIMS ANALYSIS; DESIGN OF SECURITIES; DIFFUSION PROCESSES IN FINANCE; FINANCIAL ENGINEERING; INTEREST RATE OPTIONS; OPTION PRICING THEORY; OPTIONS; SPANNING IN SECURITY MARKETS.

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design of securities. Historically, firms have mainly used debt and equity to finance their activities. Traditional corporate finance theories, such as the Modigliani-Miller theorem and its extensions, have focused on the use of debt and equity and have taken the design of these as given. Unfortunately, these traditional theories have been unable to explain the financial policies firms adopt. This has brought the issue of security design to the fore since an understanding of the basic determinants of the structure of securities

should lead to a greater understanding of firms' financial policies.

Some insight into security design is gained from considering the process of financial innovation. This is not just a recent phenomenon; firms have used securities other than debt and equity for many centuries. For example, English companies issued multiple classes of stock as early as the 16th century and convertible securities in the 17th and 18th centuries. However, it has been suggested that financial innovation has proceeded at a particularly fast pace during the last 20 years. One theory is that this innovation is in response to changes in the tax code and regulation. Another is that it makes markets more complete by increasing the opportunities for risk sharing among investors. In a study of recent innovations, Finnerty (1988) categorized risk reallocation as a primary factor responsible for the security's introduction in a majority of cases; tax and regulatory advantages were a primary factor in a minority of cases. Tufano (1989) has conducted an empirical investigation of the incentives for investment banks to introduce financial innovations. He finds that increased market share is the main advantage gained.

There have been two strands of literature on the theory of security design (see Allen 1990 for a survey). The first has been concerned with identifying the circumstances in which debt and equity are optimal. Townsend (1979), Diamond (1984) and Gale and Hellwig (1985) have shown debt can be an optimal contract between a risk-averse borrower and a risk-neutral lender if observing the borrower's earnings is costly.

This theory is a good explanation of the use of debt contracts when banks lend to individuals and small firms. However, it is not a satisfactory explanation of the use of debt by public corporations since their earnings can be costlessly observed. Standard contract theory suggests that optimal risk sharing between the lender and the borrower will require the payment on the debt to depend on the level of earnings even when the firm is not bankrupt. Typically, this does not happen in practice.

A number of recent papers have argued that the use of non-contingent contracts results from asymmetric information (see Nachman and Noe 1990; De and Kale 1990; Allen and Gale 1992). In these models contingent contracts will be preferred by firms with low expected earnings since their expected interest payments will be low. As a result, any firm offering a contingent debt contract will be presumed to have low earnings and will be valued accordingly, so all firms will prefer to use non-contingent debt.

A rather different approach by Aghion and Bolton (1988) and Zender (1989) to the optimality of debt and equity, is based on the allocation of control rights. In these theories, which assume all agents are risk neutral, contracting possibilities are incomplete in the sense that it is not possible for the lender and the borrower to include clauses for every eventuality. As a result managers do not have the correct incentives if only equity is used. The allocation of control rights to equity-holders when earnings are high, and to debtholders when earnings are low, allows better incentives to be provided.

The holders of equity have responsibility for the operation of the firm through the election of the board of directors.

Typically, the allocation of voting rights is one-share-one-vote. However, multiple classes of equity with unequal voting rights are sometimes observed, particularly in European countries. Grossman and Hart (1988) and Harris and Raviv (1988, 1989), among others, have considered the case when issuing one-share-one-vote equity maximizes the value of the firm. The context analysed is where a raider is competing with an incumbent management. If one group or the other (but not both) has private benefits of control, such as psychic enjoyment from running the firm, then one-share-one-vote is optimal because it maximizes the amount the raider must pay to obtain control. If both groups have private benefits of control then concentration of votes is optimal because this forces them to compete for control and pay for the associated private benefits they obtain.

The second strand of the literature on security design has considered the characteristics of optimal securities. In Allen and Gale (1988), there are transaction costs of issuing securities and restrictions on short sales. Firms design the securities they issue to maximize firm value. It is shown that this profit-motivated design of securities leads to an efficient allocation of resources. In Allen and Gale (1991), a model where there are no short sales restrictions is developed. In this case profit-motivated design of securities does not lead to an efficient allocation of resources because short sellers are able to compete away part of the benefits of innovation.

In Allen and Gale (1990) the owner of an options exchange (which is costly to set up) is the agent designing the securities. If the owner can capture all the benefits of the exchange, security design is efficient. In practice, this is not likely to be possible and security design is likely to be inefficient.

Gale (1990) develops a model of security design by the government. Among other things, he demonstrates that lengthening the maturity structure of public debt can sometimes make everybody better off because of improved opportunities for risk sharing.

Duffie and Jackson (1989) consider the optimal design of securities by futures exchanges. The objective of the exchanges in choosing the futures contracts to be traded is to maximize volume. It is shown that a monopolistic contract design leads to a Pareto-optimal allocation of resources but in other situations the allocation is not necessarily efficient.

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See also ASYMMETRIC INFORMATION; DEBT RENEGOTIATION; DERIVATIVE PRODUCTS; FINANCIAL ENGINEERING; INCOMPLETE FINANCIAL MARKETS; LOAN CONTRACTS; MODIGLIANI-MILLER THEOREM; UNBUNDLING.

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Deutschemark. The Deutschemark was introduced in the western sectors of Germany on 20 June 1948. It replaced the Reichsmark which, having been ruined by the inflationary financing of the war, was no longer generally accepted as a means of payment; it also brought to an end the use of cigarettes as a currency substitute. On Sunday 20 June a *per capita* amount of DM 40 was handed out to every German in exchange for Reichsmark and an additional DM 20 two months later. Firms received DM 60 per employee. All regular payments like wages, rents, etc. were converted at a 1:1 ratio. For deposits the conversion rate between Reichsmark and Deutschemark was initially fixed at 10:1, but was subsequently lowered to 10:0.65 to reduce the inflationary pressures that emerged in the weeks following the currency reform. Loans and mortgages were reduced to one tenth of their original amount. However, the liabilities of the German Reich and of the Nazi Party were cancelled altogether.

The birth of the Deutschemark was more than just a renaming of the old currency and a wiping out of some zeros to eliminate the monetary overhang, it established a new monetary regime and was combined with a policy of de-control and of tax reduction for which there was no counterpart in Europe at that time. This bold step of Ludwig