# Theorems and Theories of Financial Innovation: Models and Mechanism Perspective

**Article** · January 2013

DOI: 10.12966/fqa.05.02.2013



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Sciknow Publications Ltd.
Financial and Quantitative Analysis

FQA 2013, 1(2): 26-29
DOI: 10.12966/fqa.05.02.2013

# Theorems and Theories of Financial Innovation: Models and Mechanism Perspective

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**Abstract –** Innovation is basic need of the hour to attract new customers to the financial markets. 'Financial Innovation' means finding new products and new features for existing financial products. Thus creating a new financial product or adding new features to existing financial product is the central theme of financial engineering. Hence, the innovative products should try to reduce financial risk and it should aim to reach 'financial optimization'. Innovation is mainly driven by modern Globalization and investors and government resulting in exposing to new and wider international risk, innovation becomes a new tool to solve, manage and transfer the entire extra burden. The deregulation of banking systems, in particular, promotes economic growth through improved allocation, efficiency and a reduction of financial service costs.

**Keywords –** Financial Innovation, Financial Instruments, Theorem and Theories and Models

## 1. Introduction

Financial innovation is a essential force motivating the financial system toward greater economic competence with considerable economic advantage accruing from the changes over the time. In the process of creating a new financial product, a financial engineers needs to acquire knowledge of optimization and financial modeling techniques besides basic theory of financial management.

## 2. Need for Financial Innovation

A crucial function of the financial system is to help companies and households to manage risks. The discharge of this function depends on the type of financial products or contracts available to companies and households to hedge and take on exposures in close alignment with their individual risk preference and tolerance, as well as the capability of the institutions that make up the financial system to manage the risk inherent in these products. One must also be borne in mind that imperfections within financial markets will affect the performance of these innovative financial products that may in turn limit their availability. One might call such assets 'natural assets' as the same instrument that is issued by the borrower is also held by the investor. In this example, the role of the financial system is simply to facilitate the intermediation between end-borrowers and end-investors, and, in some cases, to provide a secondary market in the asset, intermediating between alternate end-investors.

## 3. Review of Literature

Levich (1985) study made a broad assessment of these recent developments surrounding financial innovation, including their impact on financial stability and national policy-making. This theme suggests several basic questions: (Levich,1985) What financial product and process changes have occurred over the last twenty to twenty-five years in U.S. and international financial markets? (Tufano, Peter, 1989) What factors account for these changes? (Smith et al, 1990) What are the implications of these changes for individuals and the aggregate macro economy from both a positive and policy perspective?

Tufano (1989) examines a cross-section of new securities to examine whether financial product innovators enjoy first mover advantages. He finds that, over the 1974-1986 period, investment banks that created new products did not charge higher prices in the period before imitative products appear and in the long run charge lower prices than rivals.

Smith, Smithson, and Wilford (1990) document the increase in the volatility of interest rates, exchange rates, and commodity prices, and draw a relation between increase in riskiness and financial innovation.

Verghese (1990) states that it is necessary to take a close look at the main features of the current wave of financial innovation and evaluate objectively what it has achieved and at what cost. It is also important to identify the lessons the financial change and innovation. He made a comprehensive study of Indian financial system and financial innovation.

Merton (1992), focused on the future perspective of financial innovation and he explained functional perspective of financial intermediation. His studies are about financial innovations, lower cost of capital, reduce financial risks, improve financial intermediation, and hence welfare enhancing. According to him 'the growing need of financial innovation in stimulating economic growth and businesses operations indeed can be viewed by explaining functions it has performed'.

Levine (1997) opines that the most of the empirical studies had confirmed that finance or financial system is the heart of the economy which determined economic growth in an economy. This perhaps displays the growing significance of financial innovation as a casual contributor in stimulating the economic growth and reengineering businesses particularly in emerging economies.

Tufano (2003) provides the standard explanation for financial innovation is that it helps correct some kind of market inefficiency or imperfection. For example, if markets are incomplete then financial innovation can improve opportunities for risk sharing. If there are agency conflicts, then new types of security can improve the alignment of interests. Other important motivations for financial innovation are to lower taxes or to avoid the effects of regulations. Since both issuers and buyers must benefit from an innovation for it to be successfully introduced, the traditional view of financial innovation has been that it is desirable.

John D Finnerty (2002) compiled an informative list of the financial innovations and factors that are primarily responsible for innovation. The compilation covered consumer type financial instruments, securities, financial processes, and financial strategies/solutions based on the tax advantages, reduction of risk of volatility in interest rates, reallocation of risk, reduction of transaction and agency costs, increase in liquidity etc.

Frame and White (2004 found that regulations tend to spur a series of financial innovations. There exists a positive relationship between individual's education and income and use of the new financial technology by consumers. Financial innovators tend to gain by first mover advantages and re compensated well for their efforts.

Draghi (2008), observed that 'regulation must not prevent innovation, which is necessary if we are to improve product choices for consumers and an expanded access to credit. Thus, the goal will be to strengthen the resilience of the system without hindering the process of market discipline and innovation that are essential to the financial sector's contribution to economic growth'.

## 4. Theorems and Theories of Financial Innovation

**Modigliani-Miller theorem*:*** Modigliani and Miller (1958) proved that the financial structure of the firm, i.e., the firm's choice between equity and debt financing, does not affect its value. Their study finds that taxes and regulation are the only reason for investors to mind what kinds of securities firms issue. The theorem states that the structure of a firm's liabilities should have no bearing on its net worth. The securities may trade at different prices depending on their composition, but they must finally add up to the same value. The following formulae are derived in the MM theorem, where as: Vu represents the value of unlevered firm and Vl represents the value of levered firm.

Proposition I: $V_U = V_L$

Proposition II:

$$k_e = k_0 + \frac{D}{E}\left(k_0 - k_d\right)$$

1. $k_e$ : The required rate of return on equity,
2. $k_0$ : The company unlevered cost of capital (ie assume no leverage).
3. $k_d$ : The required rate of return on borrowings,
4. $\frac{D}{E}$ : The debt-to-equity ratio.

**Markowitztheorem:** Markowitz (1959) developed the mean-variance portfolio selection theory, which suggests that investors should fully broaden their horizons and their portfolios should be a mixture of the "market" and a risk-free investment. Investors with different risk/return goals can use leverage to increase the ratio of the market return to the risk-free return in their portfolios. This is based on Capital Market Line (CML) equation as mentioned below:

RP = IRF + (RM - IRF)σP/σM

Where,

RP = Expected Return of Portfolio

RM = Return on the Market Portfolio

IRF = Risk-Free rate of interest

σM = Standard Deviation of the market portfolio

σP = Standard Deviation of portfolio

**Black Scholes Merton's Option Pricing Theorem:**

In the early 1970's, Fischer Black, Myron Scholes, and Robert Merton achieved a major breakthrough in the pricing of European stock options. The breakthrough was to set up a riskless portfolio consisting of a position in the stock and the option, and arguing that the return of the portfolio over a short period of time. This is similar to what we did in developing the binomial model, but more complicated because the weights needed to form a riskless portfolio change continuously through time. This formula can price European optionson stocks or stock indices paying a known dividend yield. The yield is expressed as an annual continuously compounded rate q. Values for a call price c or put price p are:

$$c = se^{-qt}\Phi(d_1) - xe^{-rt}\Phi(d_2) \quad [1]$$

$$p = xe^{-rt}\Phi(-d_2) - se^{-qt}\Phi(-d_1) \quad [2]$$

$$d_1 = \frac{log(s/x) + (r - q + \sigma^2/2)t}{\sigma\sqrt{t}} \quad [3]$$

$$d_2 = d_1 - \sigma\sqrt{t} \quad [4]$$

where:

Here, log denotes the natural logarithm, and:

- s = the price of the underlying stock
- x = the strike price
- r = the continuously compounded risk free interest rate
- q = the continuously compounded annual dividend yield
- t = the time in years until the expiration of the option
- σ = the implied volatility for the underlying stock
- Φ = the standard normal cumulative distribution function.

**Garman and Kohlhagen (1983) Theorem*:*** Garman and Kohlhagen's mathematical theorem is identical to Merton's (1973) theorem for options on dividend-paying stocks. They have extended the Black-Scholes valuation formula in order to incorporate options on forex. Only the term q, which did represent a stock's dividend yield, now represents the foreign currency's continuously compoundedrisk-free rate. Hence, the domestic currency value of a call option into the foreign currency is

$$c = S_0 \exp(-r_f T)\mathbb{N}(d_1) - K\exp(-r_d T)\mathbb{N}(d_2)$$

The value of a put option has value

$$p = K\exp(-r_d T)\mathbb{N}(-d_2) - S_0\exp(-r_f T)\mathbb{N}(-d_1)$$

where:

$$d_1 = \frac{\ln(S_0/K) + (r_d - r_f + \sigma^2/2)T}{\sigma\sqrt{T}}$$

$$d_2 = d_1 - \sigma\sqrt{T}$$

$S_0$ is the current spot rate

$K$ is the strike price

$N$ is the cumulative normal distribution function

$r_d$ is domestic risk free simple interest rate

$r_f$ is foreign risk free simple interest rate

$T$ is the time to maturity (calculated according to the appropriate day count convention)

and $\sigma$ is the volatility of the FX rate.

**Ross and Arbitrage Price Theory(APT)*:***The Arbitrage Pricing Theory (APT) was developed primarily by Ross (1976). It is a one-period model in which every investor believes that the stochastic properties of returns of capital assets are consistent with a factor structure. He states that if equilibrium prices offer no arbitrage opportunities over static portfolios of the assets, then the expected returns on the assets are approximately linearly related to the factor loadings. The APT states that if asset returns follow a factor structure then the following relation exists between expected returns and the factor sensitivities:

$$E(r_j) = r_f + b_{j1}RP_1 + b_{j2}RP_2 + \cdots + b_{jn}RP_n$$

Where:

$RP_k$ is the risk premium of the factor,

$r_f$ is the risk-free rate,

Risky asset returns are said to follow a factor structure if they can be expressed as:

$$r_j = a_j + b_{j1}F_1 + b_{j2}F_2 + \cdots + b_{jn}F_n + \epsilon_j$$

Where:

$a_j$ is a constant for asset $j$

$F_k$ is a systematic factor

$b_{jk}$ is the sensitivity of the $j$th asset to factor $k$, also called factor loading,

and $\epsilon_j$ is the risky asset's idiosyncratic random shock with mean zero.

## 5. Models and Mechanism of Innovation in Financial Engineering

**John D Finnerty** identified numerous financial innovations from adjustable rate preferred stock to zero-coupon convertible debt. These can be further classified into three types of activities viz., 1) securities innovation, 2)innovative financial processes and 3)creative solutions to corporate financial problems.

**Richard Rol model** states that there should be demand for instruments that open up new types of investment opportunities, but not for instruments that merely repackage existing risks. Thus, investors cannot invest in the entire market. This implies there should be demand for instruments that open up new types of investment opportunities. Because investors closer to being able to buy the entire market. But not for instruments that merely repackage existing risks As investors already have as much exposure to those risks in their portfolio. If the world existed as the Arrow-Debreu model posits, then there would be no need for financial innovation.

**The Arrow-Debreu model:** Arrow (1953) and Debreu (1959) extended the existing economic models by incorporating uncertainty and showed how to solve the corresponding asset allocation problem. This model assumes that investors are competent to purchase securities that pay off if and only if a certain state of the world occurs. Investors can then combine these securities to create portfolios that have whatever payoff they desire. The fundamental theorem of finance states that the price of assembling such a portfolio will be equal to its expected value under the appropriate risk-neutral measure.

**Treynor, Sharpe, Linter &Mossin Model:** Sharpe (1964), Lintner (1965), and Mossin (1966) extended the Markowitz theory and created the so-called capital asset pricing model (CAPM). This is used to determine a theoretically appropriate required rate of return of an asset, if that asset is to be added to an already well-diversified portfolio, given that asset's non-diversifiable risk. The model takes into account the asset's sensitivity to non-diversifiable risk (also known as systematic risk or market risk), often represented by the quantity beta (β) in the financial industry, as well as the expected return of the market and the expected return of a theoretical risk-free asset.

**Black and Scholes (1973):** This is a mathematical model of a financial market containing certain derivative investment instruments. From the model, one can deduce the Black–Scholes formula, which gives the price of European-style options. The formula led to a boom in options trading and legitimized scientifically the activities of the Chicago Board Options Exchange and other options markets around the world.

**Vasicek (1977) Model:** This was the first model to propose an analytically tractable model taking into account the mean reversion property of the instantaneous interest rate and the pull-to-par property. This model is a mathematical model describing the evolution of interest rates. It is a type of "one-factor model" as it describes interest rate movements as driven by only one source of market risk. The model can be used in the valuation of interest rate derivatives, and has also been adapted for credit markets, although its use in the credit market is in principle wrong, implying negative probabilities

# 6. Conclusion

This paper deals with various important issues of financial innovation. The process of creating innovative financial securities in terms of technical aspects and derivative pricing that offers new pay-offs to investors is the part of financial innovation. This paper also discussed various models and theorems of innovation, genesis of finance and financial engineering.

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