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DOKUZ EYLÜL ÜNİVERSİTESİ
SOSYAL BİLİMLER ENSTİTÜSÜ
İNGİLİZCE İŞLETME ANABİLİM DALI
İNGILIZCE FINANSMAN PROGRAMI
YÜKSEK LİSANS TEZİ

REAL OPTIONS BASED ANALYSIS OF STOCK RETURNS: THE CASE OF ISTANBUL STOCK EXCHANGE

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Danışman
Yard. Doç. Dr. Habil GÖKMEN

2009

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ABSTRACT

Master's Degree Thesis

Real Options Based Analysis of Stock Returns: The Case of Istanbul Stock Exchange

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It is widely accepted in financial economics that it is crucial to provide performance efficiency of asset pricing mechanism because a well-regulated stock market renders an important package of economic services. However, some financial economists uncovered a wide variety of stock market anomalies that cannot be explained by traditional asset pricing models. This study relates the explanation of these anomalies to non-normal equity return distribution found over the cross section of firms.

The main purpose of the current study is to discuss stock market anomalies by linking empirical studies with Real Options Theory. Performance of stock returns was examined by utilizing dynamic portfolio grouping. It was tested if sorting along growth options results in asymmetry in the return distributions of stock portfolios. The results of the research indicated that the risk and pay-off characteristics of growth options appear to introduce differences in the performance of stocks. It was observed that return distribution of portfolios composed of firms with more growth options have higher value of variance, skewness and mean.

There have been many studies about anomalies in Istanbul Stock Exchange (ISE), but what makes the contribution of this thesis incremental to existing literature is that it provides real options based explanation for pricing anomalies by using stock return data of non-financial firms listed in ISE.

Key Words: Asset Pricing Models, Efficient Market Hypothesis, Equity Return Distribution, ISE, Present Value of Growth Options, Real Options, Stock Market Anomalies.

ÖZET

Yüksek Lisans Tezi

Hisse Senedi Fiyatlarının Reel Opsiyonlara Dayalı Analizi:
İstanbul Menkul Kıymetler Borsası Örneği

Mirbek DZHOLBUNOV

Dokuz Eylül Üniversitesi
Sosyal Bilimler Enstitüsü
İngilizce İşletme Anabilim Dalı
İngilizce Finansman Programı

İyi düzenlenmiş bir hisse senedi piyasası ekonomiye önemli hizmetler sağladığı için, varlık fiyatlandırma mekanizmasında performans etkinliğinin sağlanması finansal iktisatta büyük önem taşımaktadır. Fakat bazı finansal ikstisatçılarının çalışmaları, hisse senedi piyasalarında geleneksel varlık fiyatlandırma modellerinin açıklayamadığı bir takım anomalileri ortaya çıkarmıştır. Bu çalışmada, anomaliler hisse senetleri getirilerinin dağılımında gözlemlenen anormalliklerle ilişkilendirilmektedir.

Tezin temel amacı ampirik literatürdeki sonuçları Reel Opsiyon Teorisi ile ilişkilendirmek suretiyle hisse senedi pazarında bulunan anomalileri sorgulamaktır. Araştırma, şirketlerin büyüme opsiyonlarının miktarına göre oluşturulan hisse senedi portföy getirilerinin normal dağılımlarının birbirlerinden farklı olup olmadığının incelenmesi yoluyla gerçekleştirilmiştir. Yapılan analizler neticesinde, büyüme opsiyonlarının risk ve getiri özellikleri getiri performanslarında fark yarattığı gözlemlenmiştir. Büyüme opsiyonları diğerlerine nispeten daha fazla olan şirketlerden oluşan potföylerin getiri dağılımlarının çarpıklık, varyans ve ortalama değerlerinin daha yüksek olduğu görülmüştür.

İstanbul Menkul Kıymetler Borsası (IMKB)'ndaki fiyat anomalileri ile ilgili bu güne kadar bir çok çalışma yapılmıştır. Ancak bu çalışmayı literatürdeki diğer çalışmalardan ayıran en temel özellik, fiyat anomalilerinin İMKB'de listelenen, mali olmayan şirketlerin getiri verilerini kullanarak ve Reel Opsiyon Teorisi esas alınarak incelenmesidir.

Anahtar Kelimeler: Büyüme Opsiyonlarının Şimdiki Değeri, Etkin Piyasa Hipotezi, Hisse Senedi Getirilerinin Normal Dağılımı, Hisse Senedi Piyasasındaki Anomaliler, İMKB, Reel Opsiyonlar, Varlık Fiyatlama Modelleri.

REAL OPTIONS BASED ANALYSIS OF STOCK RETURNS: THE CASE OF ISTANBUL STOCK EXCHANGE

CHAPTER II

ASSET PRICING MODELS AND STOCK MARKET ANOMALIES

CHAPTER III

REAL OPTIONS BASED EMPIRICAL RESEARCH ON ISTANBUL STOCK EXCHANGE

LIST OF ABBREVIATIONS

APT	Arbitrage Pricing Theory
BV/MV	Book-to-Market ratio
CAPM	Capital Asset Pricing Model
CCAPM	Consumption-Based Capital Asset Pricing Model
CML	Capital Market Line
DCF	Discounted Cash Flow
EMH	Efficient Market Hypothesis
E/P	Earnings-to-Price ratio
et al.	et alii (=and other people)
FCF	Free Cash Flow
HML	The difference between the return on a portfolio of high-book-to-market stocks and the return on a portfolio of low book-to-market stocks
ICAPM	Intertemporal Capital Asset Pricing Model
IP	Intellectual Property
ISE	Istanbul Stock Exchange
JV	Joint Ventures
MDCF	Modified Cash Flow
NPV	Net Present Value
NYSE	New York Stock Exchange
OPT	Option Pricing Theory
ROA	Real Options Analysis
SMB	The difference between the return on a portfolio of small stocks and the return on a portfolio of large stocks
TFM	Three Factor Model

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INTRODUCTION

A well-regulated stock market renders a crucial package of economic services, and important functions of stock exchange include provisions for liquidity of capital and continuous market for securities from the point of view of investors. From the point of view of economy in general, a healthy stock market has been considered crucial for economic growth and is expected to contribute to improvement in productivity. An efficient performance of pricing mechanism of stock market is a driving force for channeling savings into profitable investment and thus, facilitate in an optimal allocation of capital. Ideally, as Efficient Market Hypothesis states, prices at all time reflect all available information that is relevant to the valuation of securities. But recently, some financial economists and statisticians found that stock prices can be partially predicted. They uncovered a wide variety of apparent empirical relations between average stock returns and firm characteristics that cannot be explained by traditional asset pricing models. These empirical exceptions also known as anomalies seriously have challenged the straightforward structures constructed by asset pricing models and influenced the course of empirical studies regarding equity markets for the past several years. There are many discussions of the anomalies or investment strategies in the current financial literature. This study relates to non-normal equity return distribution and presents an explanation based on real options and asymmetry in returns found over the cross section of firms. Anomalies are often interpreted as evidence of market inefficiency, but it may also be indication that the market is efficient but the underlying asset-pricing model is inadequate.

By incorporating future possible outcomes into the stock price's information, real options can be a more sophisticated alternative to traditional discounted cash flow analysis. In the stock market context, real options value may be imputed from the fact that the stock market value may exceed the estimated equity value of the existing businesses of the company. Equity return, in addition to the risk of assets in place, also depends on the risk of growth options. The risk-return profile of a firm is influences by the existence of growth options, and this may help explain the risk

factors presented by Fama and French when firms have different levels of growth prospects. The differences in growth options value across firms induce asymmetry in equity returns, but beta ignores this asymmetry and overestimates the risk of growth options because it neglects the preference for upwards potential. The risk-return dynamics of the firm is influenced by the presence of real options in a corporate asset portfolio and over time this influence will be reflected in corporate stock prices. In this research, embedded growth option value in stocks are considered as a package of corporate real options, and Real Option Theory is used to investigate the value and behavior of stocks with embedded growth option value.

The main purpose of the current study is to discuss stock market anomalies by linking empirical studies of anomalies with Real Options Theory. This study incorporates insights from Real Options Theory into empirical finance and tests whether the existence of growth options introduces asymmetry in the equity return distribution, which in turn may lead to a wrong estimator of mean-variance-based beta. This thesis will therefore focus on the difference in return distribution of firms with varying portion of growths options embedded in the stock price. This new direction of real option research can be seen as complementing the more static methods of stock analysis and, perhaps, can provide a better understanding of the regularities that are found in the cross-sectional return distribution in empirical studies.

There has been an enormous body of literature about stock market anomalies and their explanations. As it impossible to include all of the literature and explanations within a single study, the scope of the study has been restricted to mainly size and value anomalies, explained based on real options and asymmetry in returns found over the cross section of firms. In this study, stock returns of non-financial firms whose data were offered to the public at Istanbul Stock Exchange were examined by utilizing dynamic portfolio grouping. Financial firms are excluded because high leverage that is normal for these firms does not have the same meaning as for nonfinancial firms. Firms without available firm specific variables are also

excluded from the data. After all adjustments in the data, a total of 144 firms remained. Sock return data used in the empirical part is based on nine years.

The incremental contribution of this thesis to existing literature is that it will provide real options based explanation for the value and size regularities using data of firms listed in Istanbul Stock Exchange. The study finds that the existence of growth options introduces asymmetry in the equity return distribution. Firms with more assets in place show a less asymmetrical return distribution, while small firms with more growth options show a more skewed return distribution. This observed asymmetry in equity returns of firms with high growth options is explained by sequential or compound option character of growth opportunities.

This thesis consists of three different chapters. The first two chapters are theoretical and will be used as an introduction to the empirical part of the thesis. The first chapter will give a description of real options as an extension of conventional valuation techniques. Option Pricing Theory will be presented without giving much information on the technical terms of option pricing. Later history of real options and its analogy to financial options will be covered. In following sections of this chapter, types of real options together with real option applications in valuation of a firm, project and securities are discussed as well. Finally stocks will be discussed within the real options analysis. The second chapter starts with the discussion of Asset Pricing Models and Efficient Market Hypothesis and later most relevant anomalies together with their possible explanations are presented. The last chapter of this thesis consists of the empirical research. In this chapter, the design of the research and proxy for growth options value are discussed first. Later the performance of stocks based on growth options embedded in stock price is empirically investigated. The thesis will end with a conclusion.

CHAPTER I

REAL OPTIONS

1.1 CONVENTIONAL VALUATION APPROACHES

1.1.1 Risk and Uncertainty

In a very competitive market environment, on their way to maximize shareholders' value, managers of the firms face investment decisions when there is an uncertainty over the future rewards from the investment. A decision maker has to assess the probabilities of all alternative outcomes that can mean greater or smaller loss (or profit) for the venture.[1] But often companies abandon research and development or fail to pursue commercial activities surrounded by uncertainty, and consequently considered too risky. The reasoning is that high uncertainty means high risk. High risk means high discount rates, which in turn means low or negative Net Present Value (NPV). This way of thinking represents a major potential trap.[2] Therefore risk has long been recognized as an important component in capital budgeting decision-making and asset pricing. Corporations that manage their risks well tend to be favored by analysts and investors. Supposedly, companies which have good risk managers will also succeed in making money. The future is full of uncertainty, and investment appraisal techniques that fail to recognize this fact will result in incorrect conclusions and erroneous recommendations.[3] In the next paragraph risk and uncertainty will be discussed in more detail.

There has been a considerable discussion and disagreement over the meaning of risk and uncertainty. In this thesis, the view attributed to the seminal work of Frank Knight will be used to explain these concepts. Knight defines risk as the form

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[1] Avinash K. Dixit and Robert S. Pindyck, Investment under Uncertainty, Princeton University Press, Princeton, New Jersey, 1994, p. 3.
[2] Jack Broyles, Financial Management and Real Options, John Wiley & Sons Ltd, Chichester, 2003, pp. 110-111.
[3] David Brookfield, "Risk and Capital Budgeting: Avoiding the Pitfalls in Using NPV when Risk Arises," Management Decision, Vol. 33, No. 8, 1995, p. 56.

of incomplete knowledge where the future can be predicted through the laws of chance. That is where probability distributions of future occurrences can be measured. Uncertainty can then be defined as the variability of future outcomes where probability distributions can not be measured.[4]

To give a better explanation of these two concepts, Knight divides the future outcomes into three categories. First are outcomes to where mathematical probability can be applied. The probability of a coin landing on heads when tossed may be included in the first category. The second are the outcomes that can be grouped and the expected outcome for the group as a whole can be determined with some certainty. The probability of a house burning down was given as an example for this category. Even if the probability of a fire cannot be determined a priori, with adequate historical evidence, it is possible to estimate the probability of a house burning down, and the expected loss caused by fire of a large number of houses can be estimated with a high degree of accuracy. Outcomes of this type can be a subject for insurance, as the individual houses can be grouped and the total loss resulting from the fire can be taken as a fixed cost for the firm which offers insurance service. The third type includes outcomes that cannot be grouped, and whose probability of occurrence cannot be estimated from historical data. Outcomes of the first and second categories are thought to be risky, while the third type of outcomes is accepted as uncertain.[5] All financial decisions deal with uncertainty by translating it into risk by using subjective chances. In contrast to an example of a coin landing on heads when tossed, financial decisions are not objective and have inherent subjective characteristics due to inability to predict all the future possibilities.

When measuring risk, investors almost always look into the past because that is where the data lies. Subjective investors implicitly assumes historical data as a good indicator of what will happen in the future and that the fundamentals which generated those past numbers did not change significantly, and translate resolved uncertainty of past stock prices into risk and give their valuation to particular companies.

[4] Frank H. Knight, Risk, Uncertainty and Profit, Cosimo Inc., New York, 2005, pp. 233-234
[5] Knight, pp. 211-223.

When management selects investments, it hopes to increase the value of the company. To do so, it must find activities that will earn a higher rate of return than the cost of capital. The cost of capital is a variable that depends upon the risk of the investment. Therefore, an essential element in the search for value-maximizing investment is estimation of the risks of different investments. Without risk estimation, management cannot ascertain the cost of capital and would not know if the rate of return expected from an activity can justify the use of capital.

It is important not to view risk, in traditional terms, as a "negative". In Webster's dictionary, risk is defined as "exposing to danger or hazard", but Chinese symbols for risk, shown in Figure 1, give a much better description of risk. The first symbol stands for "danger", while the second is the symbol for "opportunity", making risk a composition of danger and opportunity.[6] Thus uncertainty can create positive value if opportunities are used and dangers are avoided.

Figure 1: Chinese Symbols for Risk

Source: Damodaran, Strategic Risk Taking, 2007, p.5.

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1.1.2 Value and Pricing Concepts

In developed financial markets there is a competition which eventually brings efficiency into markets. The meaning of an efficient financial market is that the prices of securities reflect all price-sensitive information that is available to the participants of financial market. According to Efficient Market Hypothesis the value

[6] Aswath Damodaran, Strategic Risk Taking, Ed. 1, Wharton School Publishing, New Jersey, 2007 (Strategic Risk), pp. 5-6.

is nothing but the price it would bring in competitive market. This is determined primarily by the demand for the object relative to supply. When demand and supply are equal, equilibrium is achieved. The primary condition for equilibrium in efficient financial market is the non-existence of arbitrage opportunities. Management normally cannot increase the value of the corporation by raising funds in the financial market and then simply reinvesting the money back into the financial market. Management can increase the value of the corporation by raising funds at competitive rates in an efficient financial market and then reinvesting the funds in products and services with higher rates of return. Managers must look for profitable ventures in product markets where they can expect to enjoy some advantage over competitors. Value-maximizing investment requires the identification, analysis, and exploitation of opportunities for competitive advantage.

Traditionally, value can be defined as the single time-value discounted number that is representative of all future net profitability, but with the advent of new paradigms, new techniques of value measuring are being offered. In the following section aforementioned traditional valuation and new valuation techniques will be covered.

1.1.3 Conventional Valuation Techniques

"Valuation is the point at which theoretical finance hits the harsh road of reality."[7]

As was mentioned before, it is almost impossible to discuss valuation without uncertainties. Certain circumstances in valuation approach only exists in treasury notes transactions. By holding treasury notes, investors may enjoy a risk free rate. A simple Discounted Cash Flow (DCF) model is the optimal model for certainty valuation, but in the real world, uncertainties do affect the value and there are some pitfalls in most traditional methods of valuation, the NPV for example. Traditional analyses underestimate the flexibility value of a project and assume that all outcomes

[7] Luis E. Pereiro, Valuation of Companies in Emerging Markets, John Wiley and Sons, New York, 2002, p. vii.

are static and all decisions made are irreversible. They do not get at some of the intrinsic attributes of the asset or investment opportunity. Traditional methods assume that the investment is an all-or-nothing strategy and do not account for managerial flexibility, which implies management's ability to alter the course of an investment over time when certain aspects of the project's uncertainty become clear.[8] In fact, business decisions are made in a highly fluid environment where uncertainties abound and management is always vigilant in making changes in decisions when the circumstances require a change. When such decisions are valued in a deterministic view, the true intrinsic value of a project may be potentially grossly underestimated. New sets of rules and methodology are required in light of these new managerial flexibilities. It is thus important first to look back to the traditional valuation methods and only then, against this background, the evolution of knowledge can be appreciated in the course of time and see the turning point of valuation methods. This is exactly what is going to be done in proceeding paragraphs.

The main approach to value a firm by traditional financial theory is DCF model. DCF models are used for project evaluation by most companies, presumably because they are easy to apply and because they are intuitively attractive. The main idea of DCF approach is that the value of a project is defined as the future expected cash flows discounted at a rate which reflects the risk of the cash flow.[9] Gordon and Shapiro also used DCF in valuing a firm by assuming that the value of a firm is equal to the value of all future discounted dividends as shown below:

$$P_0 = \sum_{t=1}^{\infty} \left[D_t / (1+r)^t \right] \| \Omega \qquad (1)$$

where P_0 is a share's price at t = 0, D_t is the dividend expected at time t, and r is the required rate of profit on a share of stock and Ω is information cumulative in time,

[8] Johnathan Mun, Real Options Analysis - Tools and Techniques for Valuing Strategic Investments and Decisions, John Wiley & Sons, Inc., New Jersey, 2002, pp. 55-58.
[9] Tim Coller, Marc Goedhart, and David Wessels, Valuation: Measuring and Managing the Value of Companies, Ed. 4, John Wiley & Sons, New Jersey, 2006, p. 55.

that can change investor's preference.[10] But problem with this equation is that only dividends on outstanding stocks are included and company may decide to issue more stock in the future. To all appearance, the discounted value of dividends to stocks outstanding today will be just the value of the company's existing stock. To avoid this complexity, an assumption that existing shareholders will buy all newly issued stocks is made. Shareholders would receive all Free Cash Flow (FCF):

$$P_0 = \sum_{t=1}^{\infty} \left[FCF_t / (1+r)^t \right] \| \Omega \tag{2}$$

where P_0 is a share's price at t = 0; FCF is free cash flow of the firm at time t, which is basically income from the prior year, plus depreciation less dividends and required capital expenditures.[11] Couple of magnificent concepts, Capital Asset Pricing Model (CAPM) and cost of capital involved in NPV will be covered in the second chapter in greater detail under the topic of Asset Pricing Models.

When using this method one needs to predict the future cash flows, choose the appropriate discount rate, and find the present value of the forecasted cash flows. The NPV is calculated as the present value of future net free cash flows less the present value of implementation. If NPV is positive, then accepting the project adds value to firm. Given accurate estimates of future cash flows, the success of the discounted cash flow then will depend on how well the discount rate is chosen. If very high rate that is picked, projects that have negative NPV will be rejected; if very low rate that is picked, projects that have positive NPV will accepted.

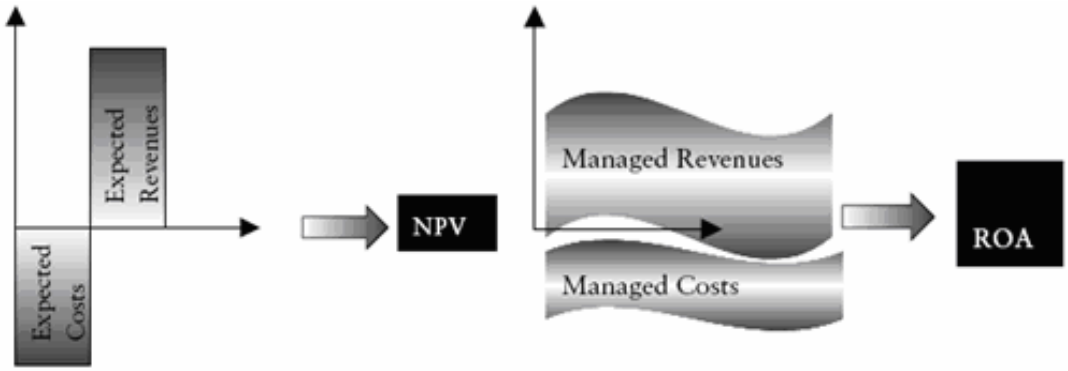
Future cash flows are estimated by developing a series of scenarios, each with a subjective probability of occurrence. Expected future cash flows for a particular project are calculated by summation of all multiplication of each scenario's cash flows with the corresponding probability. Procedure of taking the mean of all

[10] Myron J. Gordon and Eli Shapiro, "Capital Equipment Analysis: The Required Rate of Profit," Management Science, Vol. 3, No. 1, 1956, pp. 102-107.
[11] Gordon Sick, "Will Real Options Ever Get the Respect They Deserve?" Sixth Annual Real Options Conference, Paphos, Cyprus, 2002, p. 4.

possible future outcomes effectively eliminates the consideration of outcome asymmetry resulting from manager's flexibility to choose in the future the best operating mode according to the up-to-date information. Conventional DCF analysis often underestimates risky projects, not taking into account the possibility that some embedded options may help managers capture upside volatility and avoid downside loss. [12]

But it is not the same with the real option analysis, according to which management acknowledges that it will have the option to expand production and distribution once the product does well, thus taking full advantage of the upside potential as shown in Figure 2. On the contrary, if the project fails after competitive entry, management can decide to sell the asset and get the salvage value. Both costs and revenues are flexible and adjusted to the latest information. The Real Options Analysis (ROA) recognizes value creation and risk mitigation through managerial flexibility; therefore, the project appraisal looks much better.[13]

Figure 2: NPV vs. ROA



Source: Brach, Real Options in Practice, 2003, p. 5.

Last decades, with the introduction of option pricing techniques for valuing capital investment projects DCF has been experiencing challenge from the academic community. For resolving the cash flow problems of DCF different approaches

[12] Nalin Kulatilaka and Alan J. Marcus, "Project Valuation under Uncertainty: When Does DCF Fail?" Journal of Applied Corporate Finance, Vol. 5, No. 3, 1992, pp. 92-100.
[13] Marion A. Brach, Real Options in Practice, John Wiley & Sons, Inc., New Jersey, 2003, p. 5.

emerged. One is known as Modified Cash Flow (MDCF), which is based on DCF and uses decision tree techniques to explicitly model real options into decision tree.[14] The problems with the MDCF comes form the use of subjective probabilities and inappropriate discount rates. The other, option pricing approach applies Options Pricing Theory to the valuation of real capital investment projects and avoids these problems by finding replicating portfolios on the market.[15] Since DCF valuation is an attempt to estimate intrinsic value, it requires far more inputs and information than other valuation approaches. Needed inputs and information are difficult to estimate and can be a subject to manipulations by some analyst to provide the conclusion he or she wants. Another approach known as relative valuation, which is multiple-based comparison, generally requires less information than discounted cash flow valuation and intends to reflect marketwide, spot investor sentiment. While DCF-based value reflects the opinion of a single analyst or group of analysts, multiples used by relative valuation are derived from spot prices that reflect the actual value of expectations of all investors trading the asset in the market.[16]

1.2 NEW PARADIGMS IN VALUATION

1.2.1 Relative Valuation

In relative valuation the value of an asset is estimated by looking at the pricing of comparable assets relative to a common variable like earnings, cashflows, book value or sales. Investors use comparative multiples like price-earnings ratio, enterprise multiple and Market-to-Book ratio to assess the relative worth and performance of companies and to identify buy and sell opportunities. Despite its simplicity, multiple-based relative valuation methodology is powerful and extremely popular among professional appraisers because portfolio managers are judged based on how they perform on a relative basis. Relative valuation is much more likely to reflect market perceptions and moods than discounted cash flow valuation since

[14] Lenos Trigeorgis and Scott P. Mason, "Valuing managerial flexibility," Midland Corporate Finance Journal, Vol. 5, No.1, 1987, pp.14-21.
[15] Saman Majd and Robert S. Pindyck, "The Learning Curve and Optimal Production under Uncertainty," RAND Journal of Economics, Vol. 20, No. 3, 1989, pp. 336-338.
[16] Pereiro, p. 249.

multiples make it possible to measure the marketwide value perception at a particular point in time. This can be an advantage when it is important to obtain a real price reference for a potential spot buy-sell transaction. This approach is easiest to use when there are a large number of market-priced assets comparable to the one being valued, and there exists some common variable that can be used to standardize the price.

However, if not used cautiously, this valuation methodology can be a trap for investors. A portfolio composed of stocks which are undervalued on a relative basis may still be overvalued, even if the analysts' judgments are right. It is just less overvalued as compared to other securities in the market. Another possible trap may come out because of the assumption that markets are correct in the aggregate, but make mistakes on individual securities. To the degree that markets can be over or under valued in the aggregate, relative valuation will fail. Finally, relative valuation may require less information than discounted cash flow valuation in the way in which most analysts and portfolio managers use it. However, this is because implicit assumptions are made about other variables that would have been required in a discounted cash flow valuation. To the extent that these implicit assumptions are wrong the relative valuation will also be wrong.[17]

1.2.2 Contingent Claim Valuation

Although relative valuation methodology is widespread in the practical world, it ignores specific information such as: nonperforming or unwanted assets that can be sold, remaining lives of existing products, expected scale of investment in new products, expected lives of new products, expected profitability of new products and risk. Contingent claim valuation uses option pricing models to measure the value of assets that share option characteristics and facilitates incorporation of this additional information in a company valuation.[18] Traditional discounted cashflow approaches cannot properly capture the company's flexibility to adapt and revise later decisions

[17] Damodaran, Strategic Risk, pp.128-130.
[18] Merton Miller and Franco Modigliani, ''Dividend Policy, Growth and the Valuation of Shares,'' Journal of Business, Vol. 34, No. 4, 1961, pp. 411-433.

in response to unexpected market developments. Traditional approaches assume an expected scenario of cashflows and presume management's passive commitment to a certain static operating strategy. These techniques "have a big hole in them, say those who invest in the technology revolution: They don't take into account innovation ...As the communications revolution advances, the technology bulls believe, companies will create entirely new products, services and markets, and do this so rapidly that trying to analyze stock value based on current products is futile", [19] but the real option technique can value the company's flexibility to alter its initial operating strategy in order to capitalize on favorable future growth opportunities or to react so as to mitigate losses. Valuations computed using the real option technique, are often closer to market valuations for high-growth stocks in high-risk industries. A project with high growth opportunities requires high reinvestments to take full advantage of them until it reaches its mature stage. These investments can be seen as a succession of call options on future growth.[20] Since real option technique is chosen as the valuation methodology in the thesis, in the following sections Theory of Real Options will be covered in greater depth.

1.3 FINANCIAL OPTIONS

This section starts with a short introduction to options, the determinants of option value and the basics of option pricing. Some of the special issues that come up when valuing real options will be presented without spending much time on the technicalities of option pricing.

1.3.1 Option Pricing Theory

An option gives the holder the right to buy or sell a certain quantity of an underlying asset at a fixed price, which is known in option literature as a strike price or an exercise price, at or before the expiration or maturity date of the option. Since it

[19] Terzah Ewing and E.S. Browning, "The Price of Tech: Is There a Ceiling In Sight for Firms On the Cutting Edge?" Wall Street Journal, 10.01.2000, http://www.scientology-lies.com/press/wall-street-journal/2000-01-10/price-of-tech-ceiling-for-firms-on-the-cutting-edge.html (28.12.2008).
[20] Jose Pablo Dapena, "On the Valuation of Companies with Growth Opportunities," Journal of Applied Economics, Vol. 6, No. 1, 2003, pp. 53-55.

is a right and not an obligation, the holder can choose not to exercise the right and allow the option to expire.[21] There are two types of options: call options and put option. Since real options are more seen in the form of call options, throughout of the thesis, more emphasize will be given to call options.

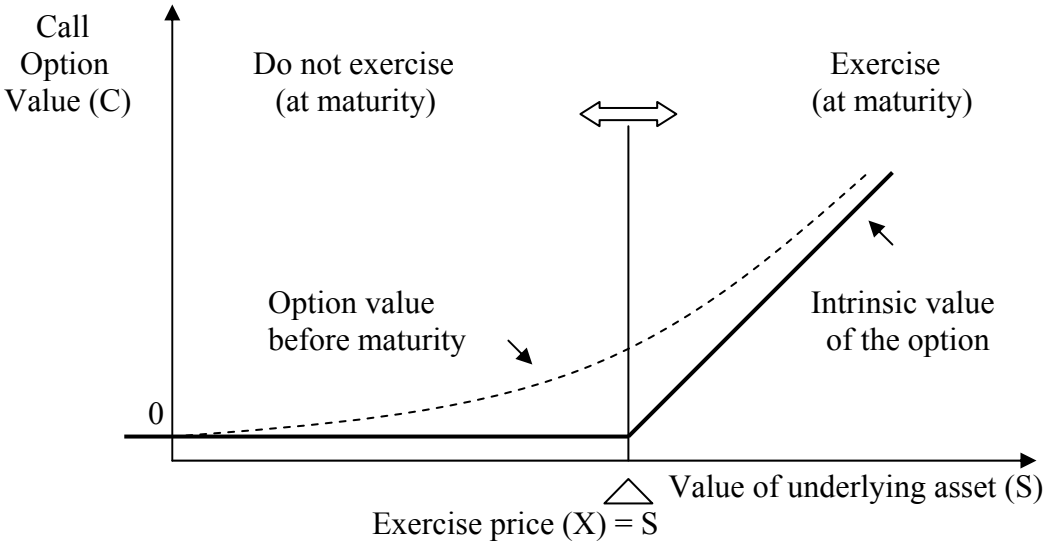
A call option gives the owner the right, but not the obligation, to buy the underlying asset at a predetermined price on or by a certain date. A European option has a predetermined exercise date and can only be exercised on that date, but an American option can be exercised at any time either on or prior to the maturity date. A put option gives the holder the right, but not the obligation, to sell the asset at a predetermined price on or by a certain date. Price of acquiring the right on the option comes at a price known as the option price or premium. The option becomes more valuable as it gets closer to the exercise price.[22] The value of the call option, *C,* is the difference between the value of the underlying asset, *S,* and the strike price *X*. Analogically, the value of the put option, *P,* is the difference between the strike price *X,* and the price at which the underlying asset can be sold at maturity, S. Figure 3 and Figure 4 visualize the standard payoff diagram for call and put options respectively. Equations 3 and 4 give the formulas for the value of a call (C) and a put (P) options.[23]

$$C = \text{Max}\,[0, S - X] \tag{3}$$

$$P = \text{Max}\,[0, X - S] \tag{4}$$

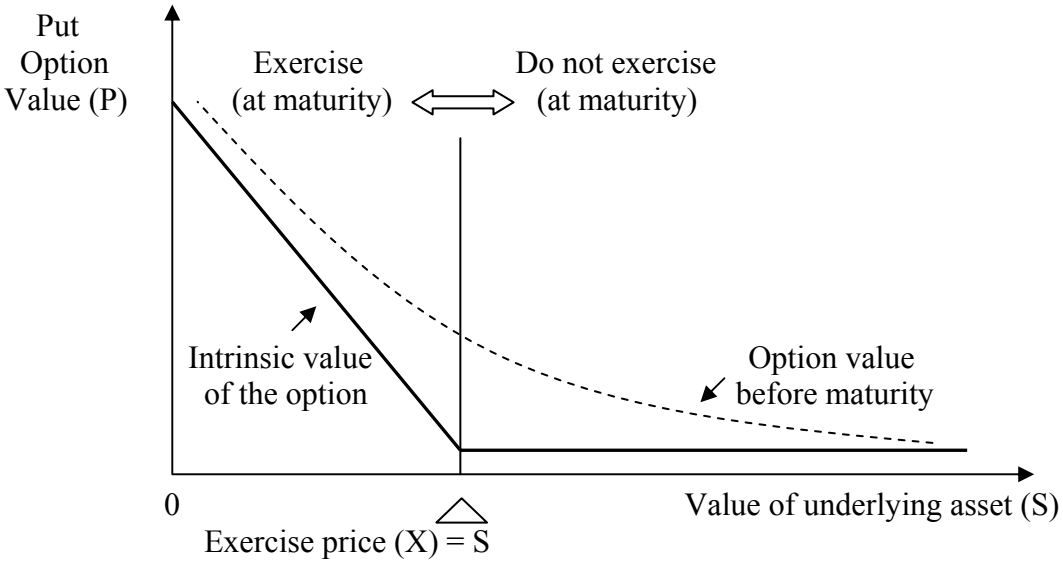
[21] John Briginshaw, Internet Valuation: The Way Ahead, Palgrave, New York, 2002, p.188.
[22] Aswath Damodaran, "The Promise and the Peril of Real Options," Stern School of Business Working Papers, 2001, (The Promise and the Peril), pp. 5-9.
[23] Jeff Madura, International Financial Management, Ed. 8, Thomson/South-Western, Ohio, 2006, p. 153.

Figure 3: Payoff Structure of a Call Option



Source: Brosch, Portfolio-aspects in Real Options Management, 2008, p. 8.

Figure 4: Payoff Structure of a Put Option



Source: Brosch, Portfolio-aspects in Real Options Management, 2008, p. 8.

Another notion that deserves to be mentioned is the time value. The dotted line showed in the Figure 3 represents the value of the call option before maturity,

which is always higher than the value of the call option at maturity.[24] For distinguishing these concepts, the value of an option at expiration is called intrinsic value, while the difference between intrinsic value and current value is known as time value of the option[25]. If the price of the stock is above a call option's exercise price, the call option is said to be in-the-money. Analogically, if the stock price is below a put option's strike price, the put option is in-the-money. The difference between an in-the-money option's exercise price and the current market price of a share of its underlying asset is referred to as the option's intrinsic value. Options have intrinsic value only when they are in-the-money.[26]

1.3.2 Basic Option Pricing Models

In this section, we introduce basic and most widely used option pricing models: Binomial and Black-Scholes Models. While the first one is a discrete time model, the second one is a continuous time one. More emphasis will be given to Black and Scholes model because it is widely accepted for pricing a European call option, and in the next sections call option is used in the example of comparing financial and real options.

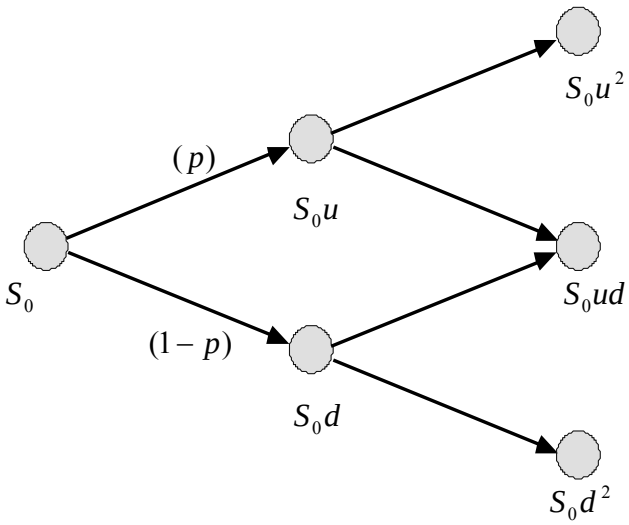
1.3.2.1 Binomial Model

The binomial model uses a discrete-time model of the varying price over time of the underlying financial instrument. It breaks down the time to expiration into potentially a very large number of time intervals, or steps. A tree of stock prices is initially produced working forward from the present to expiration. At each time interval, an assumption is made that the underlying asset price can only move from its current price to two possible levels: either up or down. This produces a binomial distribution of underlying stock prices. The tree represents all the possible ways that the stock price could take during the life of the option. The general formulation of a

[24] Richard A. Brealey and Stewart. C. Myers, Principles of Corporate Finance, Ed. 5, McGraw- Hill, New York, 1996, p. 569.
[25] John C. Hull, Options, Futures and other Derivatives, Ed. 5, Prentice-Hall, Pearson Education, New Jersey, 2002, p. 154.
[26] The Options Industry Council, "Understanding Stock Options," The Options Clearing Corporation Publications, September 2007, http://www.optionseducation.org/resources/literature/files/understanding_stock_options.pdf (11.01.2009), pp. 15-16.

stock price process that follows the binomial distribution is shown as example in Figure 5 below. S_0 is the current price of underlying asset. The price moves up to S_u with probability p and down to the S_d with probability (1 - p) in any time period.[27] Future values are above, below or at initial levels. By using a binomial tree, one can project all possible values of the underlying asset at the option's expiration date, and from them, all possible final values for the option.

Figure 5: Binomial Tree from Specific Case to General Case



Source: Broyles, Financial Management and Real Options, 2003, p. 163.

1.3.2.2 Black and Scholes Model

Black-Scholes model is mostly used to calculate a theoretical call option price using the five key determinants of an option's price: stock price, strike price, variance of returns, time to expiration, and risk free rate. Black-Scholes in its basic application is the pricing method for European call options, that is, exercise times are fixed and immediate, and can be located to a moment in time. The original formula for estimating the theoretical financial option price is as follows:

[27] John C. Cox, Steve A. Ross and Mark Rubinstein, "Option Pricing: A Simplified Approach," Journal of Financial Economics, Vol. 7, No. 3, 1979, p. 234.

Consider a European call option on a stock whose current price is S. Suppose that the stock price is lognormally distributed with volatility R*, that the option's exercise price is X, that the exercise date of the option is T , and that the continuously compounded interest rate is r . Furthermore assume that the stock will pay no dividends before the option exercise date T. Then the call price is given by:*

$$C = SN(d_1) - Xe^{-rt}\,N(d_2), \tag{5}$$

$$d_1 = \frac{\ln(S/X) + (r + \sigma^2/2)t}{\sigma\sqrt{t}} \quad and \quad d_2 = d_1 - \sigma\sqrt{t} \text{ [28]} \tag{6}$$

S = Stock price, positively related to call price as the payoff increases with the stock price;

X = Exercise price, negatively related as lower probability of being exercised;

R_f = Risk-free rate, positively related as present value of the delay of payment of exercise price becomes more valuable as interest rates rise;

σ^2 = Variance of returns**,** positively related as increased chance of exercise;

t = Time to expiry, positively related as greater chance of exceeding exercise price;

$N_{(d)}$ = Cumulative normal distribution function.[29]

Despite the fact that some practitioners in real options analysis across industries try to prevent many from using the Black-Scholes formula due to the fundamental differences between real option and financial options,[30] this model is still used by many scholars because of its simplicity. In fact, both the binomial and Black-Scholes models are based on the assumption that stock prices follow a stochastic process described by geometric Brownian motion[31]. Consequently, for European options, the binomial model converges on the Black-Scholes formula as the number of binomial calculation steps increases. More detailed and comparative

[28] Fisher Black and Myron Scholes, "The Pricing of Options and Corporate Liabilities," Journal of Political Economy, Vol. 81, 1973, p. 644.

[29] $N(d_1)$ = The proportion of shares required to replicate the call option and $N(d_2)$ = The probability that the call option will be exercised on expiry.

[30] Alex Triantis and Adam Borison, "Real Options: State of the Practice," Journal of Applied Corporate Finance, Vol. 14, No. 8, 2001, p. 14.

[31] The random movement of microscopic particles suspended in a liquid or gas, caused by collisions with molecules of the surrounding medium.

information about each of these five inputs both applied to financial and real options will be covered in the following sections.

1.4 REAL OPTIONS ANALYSIS

1.4.1 History of Real Options

Although the Theory of Real Options emerged in last centuries, the trade of options is dated back to times older than it is usually accepted. The ancient tablets found in the city of Mari, which would be now just north of today's border between Syria and Iraq, give a strong proof of option and future contracts negotiated in that area between 1800 and 1500 B.C. These contracts were used instead of commodity products. It is worth mentioning that they were used long before money in the form of coins was available.[32] Aristotle, in Book 1 of his "Politics", tells the story of Thales, the famous ancient philosopher, who made a fortune by getting into call options contract on olive presses nine months ahead of the coming harvest. He predicted favorable harvest based on his astrological observations and decided to engage, for a small fee, in contractual agreement which would provide him the right to rent olive presses in the next harvest. There was a risk due to uncertainty regarding the outcome. Thales would end up having sunk cost of option acquisition if the coming yield were to be unfruitful since there would be little need for olive presses, and Thales would not rent the presses. The option would be out-of-the-money. However, the yield turned out to be a fruitful one. He rented the presses out at high prices, while paying only a small premium for the right to exercise his call option. The very aim of Thales' engagement into this endeavor was to proof that a philosopher could get rich if money were of main interest. It is seen that uncertainty can create favorable results if the risk is correctly measured.[33]

Another example from history would be Tulip Real Options, which took place in the 1630s. These flowers, which were scarce in Europe, were brought to

[32] Brach, p. 13.
[33] Thomas E. Copeland, "The CFO and Investment Decisions - Real Options Case Histories", Weekly Toyo Keiizai, September 15, 2001, p. 1.

Holland from Turkey. Unpredictable weather and climate generated uncertainty which in turn became an incitement to the emergence of the market of futures on tulips. People engaged in transactions that gave them the right to purchase tulips at a predetermined price during the next season. Option contracts on tulips were traded not just in the Netherlands, but in England as well. In the Netherlands, tulips became the hottest and prices escalated to a very high level and then in February 1637 finally, the bubble created by tulip contracts burst. Prices were at such a high level that people started selling them, and a rapid sales of tulip bulb began, which in turn resulted in one of the first market crashes in history.[34]

"Time bargains", which were then commonly used term for options and futures, started trading in 1688, shortly after the Amsterdam Bourse opened.[35] The first formal futures and option exchange, Chicago Board of Trade opened in 1848 and began trading futures and options contracts in the 1870s. Listed stock options began trading on the Chicago Board Options Exchange in 1973[36], which coincided with the publication of the Black-Scholes seminal paper. In the paper, Black and Scholes derived a theoretical valuation formula by which pricing of call options on shares of stock could be made. With the advent of this formula the growth of option markets was facilitated, and it became the basis for valuation and pricing.[37] In the same year, Robert Merton extended their model in several important ways. These path-breaking articles have formed the fundamentals for many subsequent academic studies[38] and helped the development of the listed options and over-the-counter derivatives market.[39] In 1997 Merton and Black received the Nobel Prize in economic sciences in Stockholm.[40]

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[34] Robert J. Shiller, Irrational Exuberance, Ed. 2, Princeton University Press, Princeton, 2005 (Irrational Exuberance), p. 85.
[35] Edward Stringham, "The Extralegal Development of Securities Trading in Seventeenth-Century Amsterdam," The Quarterly Review of Economics and Finance, Vol. 43, 2003, pp. 330-332.
[36] Cox, Ross and Rubinstein, p. 230.
[37] Black and Scholes, pp. 640-645.
[38] Robert C. Merton, "Theory of Rational Option Pricing," The Bell Journal of Economics and Management Science, Vol. 4, No. 1, Spring, 1973 (Theory of Option Pricing), pp.141-183.
[39] Robert C. Merton, "Application of Option-Pricing Theory: Twenty-five years later," The American Economic Review, Vol. 33, No. 3, 1998 (Application of Option-Pricing), pp. 324-326.
[40] Alkan Soyak, "Nobel İktisat Ödülleri Üzerine Bir Yorum," Finans&Politik ve Ekonomik Yorumlar Dergisi, Vol. 40, No. 256, 2003, pp. 74-87.

But the term "real options" was first coined in 1977 by Stewart Myers, who pioneered the concept that financial investments generate real options. Stewart Myers argued that valuation of financial investment opportunities using the traditional DCF approach ignores the value of options arising in uncertain and risky investment projects because part of the value of a firm is accounted for by the present value of options to make further investments on possibly favorable terms were not included in traditional approaches.[41]

1.4.2 Real Options Analogy to Financial Options

A business opportunity of a corporation is like a call option because the corporation has the right, but not the obligation, to acquire something. For example a company may have alternative to expand production if the demand for the product increases. As was written before, there is a similarity between a call option and the business opportunity. The same analogy of measuring the value of the option is applicable in valuing the investment opportunity. However, some scholars warn against the direct application of financial option methodologies to value real options despite many obvious similarities between the two. By taking some fundamental differences between financial and real options into consideration such problems can be eliminated.[42]

Due to the simplicity of being exercisable only on its expiration date, Luehrman uses a European call option to establish a correspondence between the project's characteristics and the five Black-Scholes inputs that determine the value of a simple call option on a share of stock. Conveniently, these variables can be translated directly into “real” investment analogs as depicted in Figure 6. Supposedly, a model of the project that combines its characteristics with the structure of a call option can be obtained. [43]

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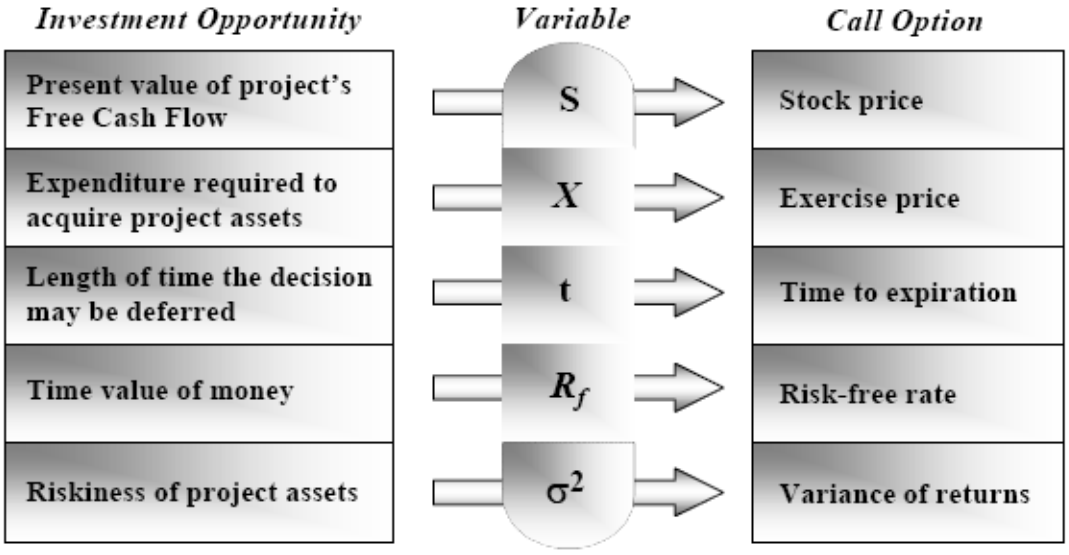
[41] Stewart C. Myers, “Determinants of Corporate Borrowing,” Journal of Financial Economics, Vol. 5, 1977 (Corporate Borrowing), pp. 149-150.
[42] Gary Gitelman, “Use of Real Options in Asset Valuation,” The Electricity Journal, Vol. 15, No. 9, 2002. p 60.
[43] Timothy A. Luehrman, “Investment Opportunities as Real Option: Getting Started on the Numbers,” Harvard Business Review, Vol. 76, No. 4, 1998, p. 52.

Figure 6: The Link between Real Options and Black-Scholes Inputs



Source: Luehrman, Investment Opportunities as Real Option: Getting Started on the Numbers 1998, p. 52

The stock price (*S*) is the value of the underlying stock on which an option is purchased. For a financial option it is simply the market's estimate of the present value of all future cashflows related with that stock. Its equivalent in real options is the present value of all cashflows that are expected from the business opportunity on which the option is purchased. Many projects involve spending money to exploit a particular business opportunity. A company may spend some money to buy or build a productive asset. This is analogous to exercising an option on a share of stock.[44]

The exercise price (*X*) is the predetermined price at which the option can be exercised. But when it comes to investments into real assets, it is much more challenging to determine the exercise price. The world of real options is much closer, in the abstract, to the painting by Klee.[45] In real options these cost corresponds to the costs and resources needed to accomplish the task and complete the project. Development of a new product or penetration into a new geographical market can be given as examples of such costs. Often these costs are only estimated or

[44] Keith J. Leslie and Max P. Michaels**, "**The Real Power of Real Options," The McKinsey Quarterly, No 3, 1997, pp. 7-9.
[45] See Appendix 1.

approximated and can not be known exactly. The exercise price for real options comprises any expense needed to put the asset that will create the future cash flows in place such as paying a licensing fee to obtain a right to a mine or to a patent. Expenses entailed to create the infrastructure for a distribution network in a new market is another example of this kind of cost.[46]

Time to expiration (*t*) is the period during which the option can be exercised. Generally, the longer the time remaining until an option's expiration date, the higher is the option premium because of the possibility that the underlying share price might move and make the option in-the-money. Time value drops rapidly in the last several weeks of an option's life. Its real option corresponding input is the period of time for which the investment opportunity is valid or the length of time the company can defer the investment decision without losing the opportunity. This period of time depends on competitive advantage, technology and contracts.

The risk-free rate (R_f) is the yield of a riskless security with the same maturity as the duration of the option, both for financial options and real options.

Variance of returns (σ^2) is a measure of the unpredictability of future stock price movements, in other words, it is the standard deviation of the growth rate of the value of future cash inflows associated with the stock. In the world of financial options, uncertainty is all about future stock prices. Uncertainty is a source of value because of the limited downside and unlimited upside fluctuations of the pay-off. These fluctuations are linked to the volatility of the price of the underlying financial assets which is outside the control of the managers. Price volatility of the underlying asset influences the option premium. The higher the volatility of the stock, the higher is the premium because there is a great possibility that the option will move in-the-money. The real options equivalent is the same, but in relation to the cashflows associated with the asset. Uncertainty, in the world of real options, has value because of the ability of executives to manage the uncertainty of projects. Managers would not be needed if there was no uncertainty. By actively managing change as

[46] Brach, pp. 17-19.

uncertainty unfolds over time, managers add value to the firm. In some way, the real options approach attempts to quantify that value of active management of uncertainty by managers. By pricing an option using values for these variables generated from the project, more can be learned about the value of the project than a simple discounted-cash-flow analysis would suggest.

1.4.3 Types of Managerial Real Options

Depending on the features of the flexibility, different types of real options are distinguished in the literature. A detailed overview can be found in Micalizzi and Trigeorgis[47], Broyles[48], and Lander and Pinches[49]. Below are eight of the main types of real options distinguished by Brach:[50]

1.4.3.1 Option to Defer

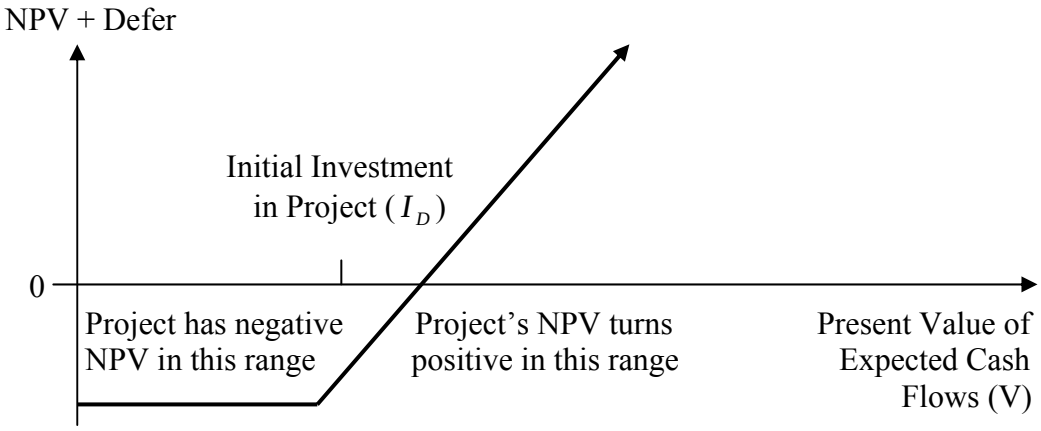
The deferral option gives a firm the opportunity to delay making the decision of whether or not to commit investment resources in a capital project. It derives its value from reducing uncertainty by delaying an investment decision until more information arrives. The option becomes valuable if by delaying, the project's risk can be reduced or its return improved. Generally, the option to defer investment bears characteristics of a call option. The option to defer investment becomes exercisable when the project's value is above the investment cost.[51]

It was mentioned that the time value of options – in the case of deferral option, it is the value generated by deferring the project's maturity time – is critical in valuing an option. When investing in a project, real option theory judges the time

[47]Alberto Micalizzi and Lenos Trigeorgis, Project Evaluation, Strategy, and Real Options In Real Options and Business Strategy: Applications to Decision Making, ed. L. Trigeorgis, Risk Books, London, 1999, pp. 1-21.
[48] Broyles, p. 135.
[49] Diane M. Lander and George E. Pinches, "Challenges to the Practical Implementation of Modeling and Valuing Real Options," Quarterly Review of Economics & Finance, Vol. 38, No.4, 1998, p.540, Table 2.
[50] Brach, p. 67, Figure 3.1.
[51] Michael Bowe and Ding Lun Lee, "Project Evaluation in the Presence of Multiple Embedded Real Options: Evidence from the Taiwan High-Speed Rail Project," Journal of Asian Economics, 2004, Vol. 15, No. 1, pp. 91-92.

value of a project more noticeably than the traditional investment analysis method. Thus in addition to considering the discount rate and the cash flow as it is done when calculating the NPV, time value should also be thought over. In Figure 7 this type of managerial option is illustrated in terms of a call option.

Figure 7: The Option to Defer a Project



Source: Damodaran, The Promise and the Peril of Real Options, 2001, p 27

In figure above, the underlying asset is the project, the exercise price of the option is the investment in the project, $I_{D,}$, and the life of the option is the period prior to which the firm has rights to take on the project. Just prior to the expiration when opportunity disappears, the opportunity (real option) value, *V*, will be taken as an American call option:

$$\text{Opportunity Value} = Max\,(V - I_{D,}\,0) \qquad (7)$$

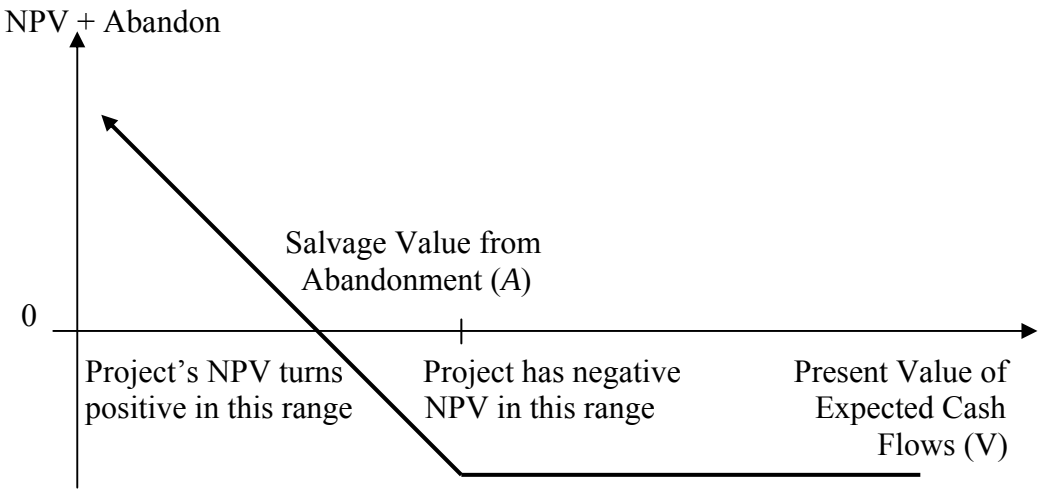
Therefore, by integrating the real option analyses, the firm value equals the NPV of the firm plus the value of the option to delay a project.

1.4.3.2 Option to Abandon

An option to abandon gives the holder an opportunity to get rid of a risky asset at a predetermined price. In financial option terms, the option to abandon is

equivalent to a put option, the right of dispose of a stock or an asset and to recover the salvage value once market conditions change or market expectations remained unfulfilled, with the investment, for example, value of the acquired firm as the underlying asset. An option is in-the-money when the value of the underlying asset falls below the exercise price, implying that there is more value in disinvesting from the project than staying invested in it. A project will be abandoned for salvage value, for example, the resale value of its capital equipment and other assets on the second hand market when its cash flows do not meet the expected amount. This kind of option can be viewed as an American put option as below:

Figure 8: The Option to Abandon a Project



Source: Damodaran, The Promise and the Peril of Real Options, 2001, p. 54.

In Figure 8, the underlying asset is the project's current value (V), the salvage value from abandonment (A) is exercise price. In this way, the option-based value of the project is:

$$\text{Option-based Value of the Project} = V + \max(A - V, 0) \Rightarrow \max(V, A) \qquad (8)$$

In general, the put option is a hedge against an economic downturn. The option to abandon a project and liquidate its assets was one of the first real options to

which option pricing theory was applied.[52] The sale of an asset, besides the compensation for losses, permits investment in new assets or more valuable real options.[53] The option to abandon is important in R&D projects, exploration of natural resources and in deals with merger and acquisition. In a merger and acquisition agreement, the option to abandon would allow the acquiring firm to back out of the acquisition at an exercise price.[54]

1.4.3.3 Option to Switch

Flexibility is widely recognized as one of the key components of a successful manufacturing strategy and defined as a capability of a firm to quickly and economically respond to various types of environmental uncertainty.[55] This flexibility or option to switch enables production systems to switch between alternative modes of operation of any given business in response to changing market conditions. Having the flexibility to exchange or switch between technologies creates value, as it permits management to respond to future uncertainties in an optimal fashion. Integrating flexibility in real estate development, for example, allows switching in the future between different uses, such as rental apartments and condominiums, office and retail space.[56] Creating operational flexibility facilitates wide-range use of assets in place and generates a real option to switch. The value of this flexibility increases as the correlation of the returns between different uses as well as the costs to redevelop and change between uses decrease. The switch option value lowers the critical threshold to invest and also affects the timing of the investment decision.

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[52] John Kensinger, "Project Abandonment as a Put Option: Dealing with the Capital Investment Decision and Operating Risk Using Option Pricing Theory," Cox School of Business Working Paper, October 1980, pp.80-121.

[53] Stewart C. Myers and Saman Majd, "Calculating Abandonment Value Using Option Pricing Theory," Sloan Working Paper, May 1983 (Abandonment Value), pp. 2-3.

[54] Tom Copeland and Vladimir Antikarov, Real Options: A Practitioner's Guide, Texere, New York, 2001, p. 126.

[55] Chen H. Chung and Injazz J. Chen, Managing the Flexibility of Flexible Manufacturing Systems for Competitive Edge, Ed. Selection and Evaluation of Advanced Manufacturing Technologies, M.J. Liberatore, Springer-Verlag, New York, 1990, pp. 280-305.

[56] Paul D. Childs, Timothy J. Riddiough and Alexander J. Triantis, "Mixed Uses and the Redevelopment Option," Real Estate Economics, Vol. 24, 1996, p.317.

The valuation of benefits resulting from investing in the flexibility to switch has been recently addressed, in a real option framework, with mathematical tools such as dynamic programming[57]and contingent claims analysis.[58] The pioneering application was the option to switch in the mining industry by analyzing the closing and opening of the mine as the two switching extremes of operations. [59] The option to switch between two different energy forms in running a plant can be given as example. [60] Often, switching refers to a technology; for example, one technology may be more cost effective in high-demand regions, another more cost effective in low-demand regions.[61] It is conceivable that with the change in market conditions, the relative price of inputs, outputs or the plant resale in a secondary market fluctuate, equityholders may find it preferable to abandon the current project's use by switching to a cheaper input, a more profitable output or simply sell assets of the plant in a second hand market. The basic component of the switching option that drives its value includes the costs saved or additional cash flows generated by having the ability to respond to future uncertainties and change a cost-driving operational parameter.

1.4.3.4 Option to Expand

The option to expand acknowledges managerial flexibility to increase a project's scale at a later date if it turns out that its product is more enthusiastically received in the market than originally expected. [62] In this case a firm should accept the negative NPV of the initial project to obtain much higher positive NPV in the coming future. The original investment opportunity can be thought as the initial scale project plus a call option to acquire an additional part ($x\%$) of the base-scale

[57] Bruce Kogut and Nalin Kulatilaka, "Operating Flexibility, Global Manufacturing, and the Option value of a Multinational Network," Management Science, Vol. 40, No.1, 1994, pp. 123-139.
[58] Alexander J. Triantis and James E. Hodder, "Valuing Flexibility as a Complex Option," The Journal of Finance, Vol. 45, No.2, 1990, pp. 549-565.
[59] Michael J. Brennan and Eduardo S. Schwartz, "Evaluating Natural Resource Investments," Journal of Business, Vol. 58, 1985, p. 135.
[60] Nalin Kulatilaka, "The Value of Flexibility: The Case of a Dual-Fuel Industrial Steam Boiler," Financial Management, Vol. 22, 1993, p. 271.
[61] Trigeorgis, Flexibility and Strategy, pp. 140-142.
[62] Stewart C. Myers, "Finance Theory and Financial Strategy," Midland Corporate Finance Journal, Vol. 5 No.1, 1987 (Finance Theory), pp. 6-13.

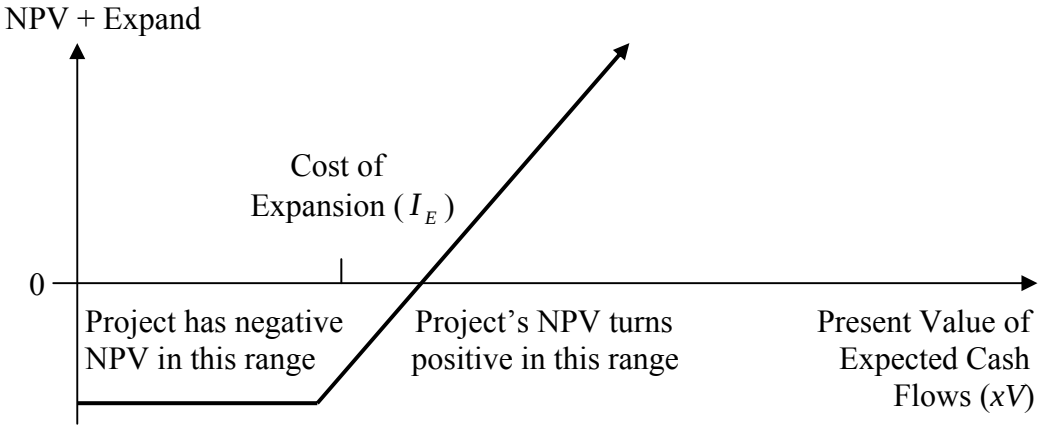
project[63], This is analogous to owning a share and having a call option on that particular share.

In Figure 9, the underlying asset is the additional part $(x\%)$ of the base-scale project (V), and the exercise price of option is the follow-on cost of expansion (I_E). Then, the total value of a project with opportunity option will be expanded as the base-scale value of a project plus the NPV of the options:

$$\text{Total Value of the Project} = V + \max(xV - I_E, 0) \tag{9}$$

The option to expand makes a seemingly unprofitable project worth undertaking by diverting traditional static NPV to dynamic option-based valuation.

Figure 9: The Option to Expand a Project



Source: Damodaran, The Promise and the Peril of Real Options, 2001, p. 44.

This option is very common in natural resource industries, in construction, fashion apparel, commercial goods as well as in real estate.[64] Without this option, the firm may find it difficult merely to increase production in response to favorable market conditions without a significant investment. With the option to expand, a

[63] Bowe and Lee, pp. 95-98.
[64] Lenos Trigeorgis, "Real Options and Interactions with Financial Flexibility," Financial Management, Vol. 22, No. 3, 1993 (Financial Flexibility), p. 204.

producer has the opportunity to increase production in the future – at a relatively lower cost – but is not obligated to do so.

1.4.3.5 Option to Contract

Analogous to the option to expand the project, the option to contract a project, gives the holder an option to contract the scale of a project's operations or switch inputs by forgoing planned future expenditures if market conditions turn out worse than initially expected. Exercising the option would involve shrinking the scale of the underlying project to operate below the project's capacity. Thereby saving at least a portion of the project's operating costs. An opportunity allowing the firm to choose between differing capacities such as different production plant sizes is typical of an option to contract. Thus, it can be seen as the opposite of the option to expand or a put option on the part of the project that can be contracted with the exercise price being the part of planned expenditures that can be forgone. The investing firm can sublease some part of its equipment or plant to another firm to offset the unused capacity of its project. The option to contract a project amounts to the initial base-case of the project while owning a put option on that project. This option is equivalent to a protective put in financial option terms. The options to expand, to contract and to abandon allow the investor to alter some configuration features of an investment such as the timing, the scale and the scope of the investment with relative ease, in time and monetary terms. Both the option to expand and the option to contract require investing in capacity that enables the firm to follow the intended action to expand or contract. [65]

1.4.3.6 Option to Grow

Growth option is a discretionary opportunity to invest in infrastructure and other productive assets at a future date. A company acquires a growth option by making an initial investment in a new market, a new product line, or a new technology. Such an investment often requires more initial outlays than the expected

[65] Rainer Brosch, "Portfolio-aspects in real options management" , Working Paper, Johan Wolfgang Goethe-Universitat, February 2001, http://www.wiwi.uni-frankfurt.de/schwerpunkte/finance/wp/578.pdf (13.05.2009). p 3.

revenue would justify, even be unprofitable, but provides the platform and future growth opportunities to invest in future ventures if and when market conditions are favorable. [66]

Growth options exist in every industry, but they are especially important for high-tech, high-risk investments. Growth options have been valued for biotech companies,[67] for the development and implementation of new software,[68] or for an entire Information Technology infrastructure, [69] including the consideration of competitive scenarios drawing on game theory.[70]

1.4.3.7 Option to Stage

Most of big projects often unfold in a series of subsequent steps, with each step relying on successful completion of the preceding one, and with management keeping the option to evaluate the project at each sequential step. The option to stage resembles a compound option.[71] But other than a growth option, the payoff for a compound option will only materialize after completion of all steps.

It may also be possible for a firm to at first, commit partially to a project in such a way that it would have the right to abandon the project during construction in case it is considered viable to do so. The option is mostly useful for valuation in the construction phase of a project.[72] It gives the investing firm the opportunity to pay only a portion of the entire construction cost of a project and keep the rest until a later period. The balance of the cost can be incurred in subsequent phases of the

[66] Walter Carl Kester, "Today's Options for Tomorrow's Growth", Harvard Business Review, Vol. 62, No. 2, 1984, pp. 157–158.
[67] Richard E. Ottoo, "Valuation of Internal Growth Opportunities: The Case of a Biotech Company," Quarterly Review of Economics and Finance, Vol. 38, 1998, p.615.
[68] Hakan Erdogmus, "Management of License Cost Uncertainty in Software Development: A Real Option Approach", Fifth Real Option Conference, Los Angeles, 2001, p 1-2.
[69] Michel Benaroch and Robert J. Kauffman, "A Case for Using Real Options Pricing Analysis to Evaluate Information Technology Project Investments," Information Systems Research, Vol. 10, 1999, p. 70.
[70] Kevin X. Zhu, "Information Transparency of Business-to-Business Electronic Markets: A Game-Theoretic Analysis," Management Science, Vol. 50, No. 5, 2004, pp. 670-672.
[71] Gonzalo Cortazar and Eduardo S. Schwartz, "A Compound Option Model of Production and Intermediate Inventories," Journal of Business, Vol. 66, 1993, pp. 519-520.
[72] Trigeorgis, Financial Flexibility, p. 216.

project. The firm effectively has the option to abandon plans to make a subsequent investment during the construction phase of the project.

1.5 VALUING A FIRM AS A REAL OPTION

Option valuation can be applied to corporate securities which can be seen as packages of claims or options on the total value of the firm as well. Thus, the underlying asset in this case is the total value of the firm's assets, the corporate securities such as equity, debt, warrants, and convertible bonds can then be valued as claims contingent on the total value of the firm's assets.

1.5.1 Valuation of Equity

As was stated before, in traditional discounted cash flow models, a firm is valued by estimating cash flows over a long time horizon and discounting the cash flows back at a discount rate that reflects the riskiness of the cash flow. By subtracting the value of debt from the total value, the value of equity is obtained. However, because of the fact that the discounted cash flow models do not reflect the equity investors' option to liquidate the firm's asset, these models understate the value of equity in firms with high financial leverage and negative operating income.

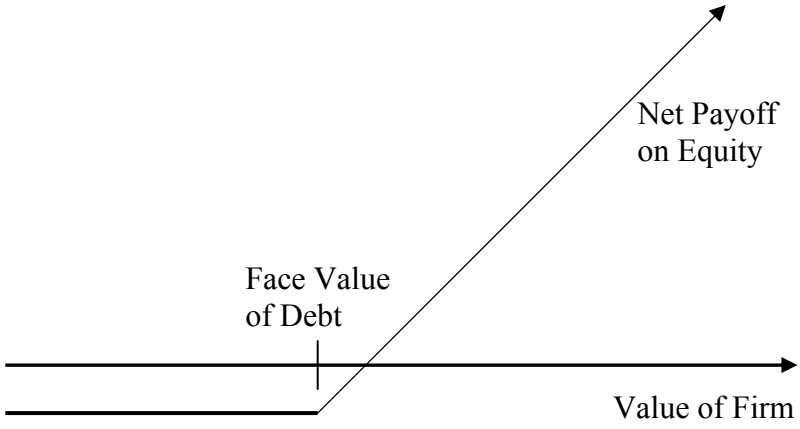
The equity in a levered firm - a firm with high leverage, negative earnings and a significant chance of bankruptcy - can be thought of as a call option, which is the option to liquidate the firm. When shareholders issue bonds, it is equivalent to selling the assets of the firm, but not control over those assets, to the bondholders in return for cash and a call option. The equity will have value even if the value of the firm's total assets falls well below the face value of the outstanding debt. Just as deep out-of-the-money traded options command value because of the possibility that the value of the underlying asset may increase above the strike price in the remaining lifetime of the option, equity will command value because of the time premium on the option (the time until the bonds mature and come due) and the possibility that the value of the assets may increase above the face value of the bonds before they come

due[73]. The equity in a firm is a residual claim, that is, equity holders lay claim to all cash flows left over after other financial claim holders have been satisfied. If a firm is liquidated, the same principle applies; equity investors receive whatever is left over in the firm after all outstanding debt and other financial claims are paid off. On the other hand, the notion of limited liability protects equity investors in publicly traded firms if the value of the firm is less than the value of the outstanding debt, and they cannot lose more than their investment in the firm.[74] The payoff to equity investors on liquidation, *E*, can therefore be written as:

$$\text{Payoff to equity investors on liquidation, } E = Max(0, V - B) \qquad (10)$$

where V is liquidation value of the firm and B is the face value of the outstanding debt and other external claims[75]

Figure 10: Equity as a Call Option on Firm's Assets



Source: Damodaran, Investment Valuation, 2002, p. 818.

Hence, the equity of a firm can be viewed as a call option with the underlying asset being the total assets of the firm, where exercising the option requires that the firm be liquidated and the face value of the debt paid off, as shown in below in

[73] Aswath Damodaran, Investment Valuation: Tools and Techniques for Determining the Value of Any Asset, Ed. 2, John Wiley & Sons Inc, New York, 2002 (Investment Valuation), p. 817-818.
[74] Gitelman, p. 59.
[75] Chung Baek, Brice Dupoyet and Arun J Prakash, "Debt and Equity Valuation of IT companies: A Real Option Approach," Florida International University Working Papers, 2004, pp. 5-6.

Figure 10, the strike price of the call option is the face value of the debt and the option premium is the investment in equity.

Equity can be considered as a deep-in-the-money call option when the total value of the firm is well above the face value of the outstanding debt. For deep-in-the-money options, time value can be ignored for most practical purposes because most of the option premium is comprised of intrinsic value. However, the equity will retain value even when the value of assets of the firm is lower than the debt outstanding - the equity is then a deep-out-of-the-money call option - because of the time premium of the option. There is always possibility that value of the assets may increase above the face value of bonds before they come due. Thus, for distressed firms, valuation of equity via option valuation is natural as well as essential to obtain a fair valuation.[76]

1.5.2 Valuation of Debt

Similarly, the debtholders at maturity of debt will receive either the promised payment, B, or the value of the firm, V, if less i.e.:

$$D(V, 0; B) = Min(V, B) \tag{11}$$

Since the value of the firm's assets must be equal to the sum of its liabilities, i.e. $V = E + D$, the value of the debt can be determined from: [77]

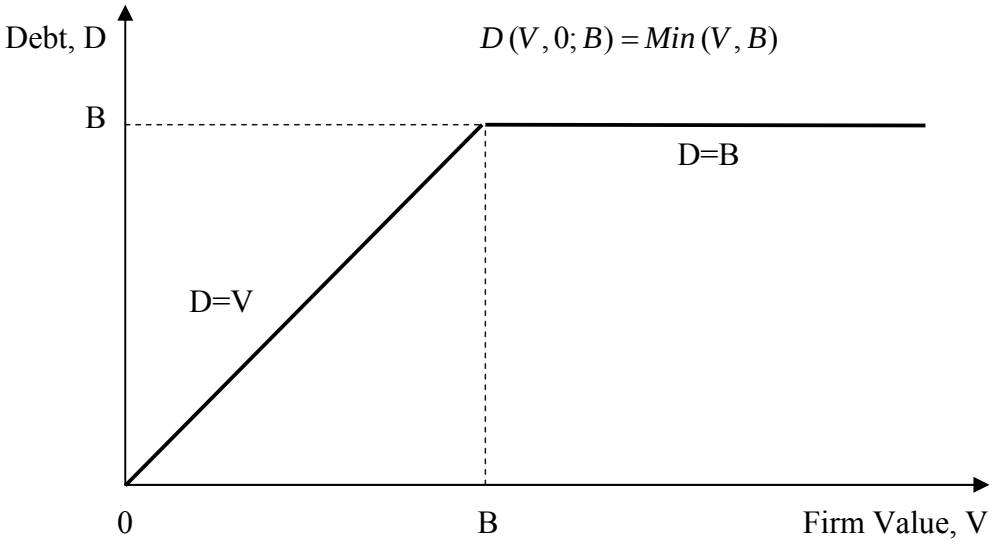
$$D = V - E \;\Rightarrow\; D = V - Max(0, V - B) \tag{12}$$

Essentially, it is as if the bondholders have effectively purchased the entire firm and written a European call option to the stockholders. The call option is on the entire firm. The face value of the debt, B, is the exercise price. This conclusion exactly compliments the analysis of the stock as a call option on the value of the

[76] Damodaran, Investment Valuation, pp.829 - 830
[77] Thomas E. Copeland, J. Fred Weston and Kuldeep Shastri, Financial Theory and Corporate Policy, Ed. 4, Pearson Education, Boston, 2004, pp. 220-225.

firm. Figure 11 shows that the value of debt depends on firm's value at the debt's maturity.[78]

Figure 11: Payoff for the Bondholders



Source: Kolb, Futures, Options and Swaps, 2003, p.565.

1.5.3 Valuation of Other Corporate Financial Claims

Not only does the real option approach can be implemented in equity and bonds valuation, but can also be implemented in valuing other corporate financial claims. Three major financial claims issued by corporations that can be valued by option approach will be further shown.

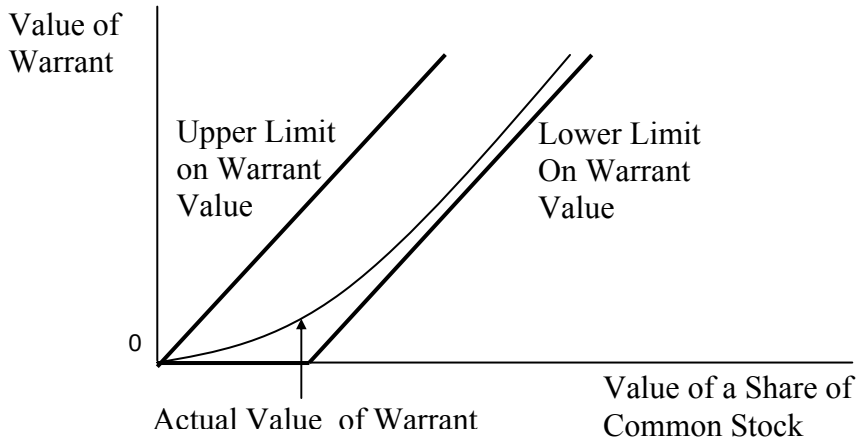
1.5.3.1 Valuation of Warrant

A warrant is a security that gives the holder the right to buy stock of the company that issued it at a specified price, which is usually higher than the stock price at time of issue. In this sense, this is very much like a call. Warrants are generally issued with privately placed bonds, though they are also combined with new issues of common stock and preferred stock. In the case of new issues of

[78] Robert W. Kolb, Futures, Options, and Swaps, Ed. 4, Blackwell Science Ltd, Maiden, 2003 (Futures) pp.565 – 566.

common stock, warrants are sometimes given to investment bankers as compensation for underwriting services. The differences in contractual features between warrants and the call option are that warrants have longer maturity periods and some of them are actually perpetual, meaning they never expire at all.[79] Besides, an underlying instrument of a call option is existing share, while the exercise of a warrant requires the issuing firm to create a new share and deliver the exerciser of the warrant. Because the warrant and the call are perfectly correlated, they will have exactly the same systematic risk and therefore the same required rate of return.

Figure 12: The Relationship between Warrant and Stock Price



Source: Brealey and Myers, Financing and Risk Management, 2003, p. 211.

The value of the warrant today depends on the value of call option adjusted for the dilution effects of the warrants. The value of warrant, W, is as follows:

$$W = \frac{1}{1+q} C \tag{13}$$

where: q = the ration of warrants to shares outstanding.[80]

[79] Eduardo S. Schwartz, "The Valuation of Warrants: Implementing a New Approach," Journal of Financial Economics, Vol. 4, No. 1, 1977 (Warrants), pp. 79-93.
[80] Robert W. Kolb, Understanding Options, John Wiley & Sons, New York, 1995 (Options), p.316.

Figure 12 shows how the value of warrant is influenced by various factors. The upper limit for the value of the warrant is the stock price and the lower limit for the value of the warrant is Max (0, Stock Price – Exercise Price). The actual value of the warrant is shown by the curved line which lies between the boundaries specified by the lower and upper limits. The distance between the actual price of the warrant and its lower limit depends on: variance of the stock return, time to expiration, risk-free rate, dividends paid off from underlying stocks, stock price, and exercise price. Most important factor that makes warrants attractive is the leverage advantage they provide. Generally, warrants cost only a fraction of the price of the underlying asset, offering higher percentage returns (positive and negative) when compared with the underlying asset.[81]

1.5.3.2 Valuation of Convertible Bonds

If the bondholders are given the right at maturity to either receive the promised payment, B, or, at their option, convert the bond into new share of equity equivalent to $x\%$ of firm value, V. The value of the convertible bond, F, can be described in terms of three components: straight bond value, conversion value, and option value.[82] Numerically the value of the convertible bond can be written as:

$$\begin{aligned} F(V, 0) &= V \quad if \quad 0 \le V \le B, && \text{Receive the firm if default;} \\ &= B \quad if \quad B \le V \le B, && \text{Receive the payment if not default;} \\ &= xV \quad if \quad V \ge B/x, && \text{Receive } x\% \text{ of V if convert,} \end{aligned} \tag{14}$$

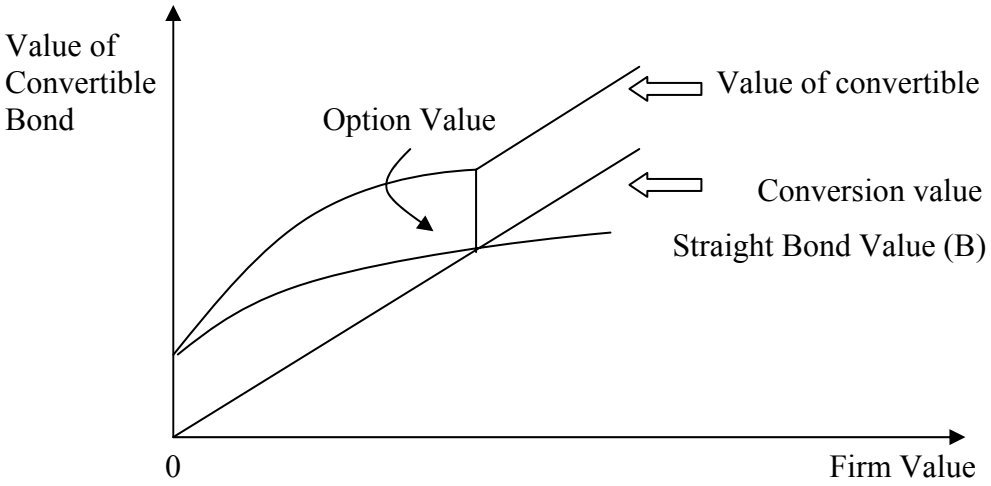
The straight bond value is what the convertible bonds would sell at if they could not be converted into common stock. It will depend on the general level of interest rates and the default risk. Conversion value is what the bonds would be worth if they were immediately converted into the common stock at current prices. Typically, conversion value is found by multiplying the number of shares of common stock that will be received when the bond is converted by the current price of the

[81] Prasanna Chandra, Financial Management, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 1992, p. 640.
[82] Trigeorgis, Flexibility and Strategy, p.112

common stock. The value of a convertible bond can either be the straight bond value or the conversion value. The reason for this is that the holders of convertibles need not convert immediately, by waiting they can take advantage of whichever is greater in the future, the straight bond value or the conversion value. This option to wait has value, and it raises the value over both the straight bond value and conversion value.[83]

The value of convertible bond is mostly influenced by their underlying value by straight debt when the value of the firm is low and mostly determined by their underlying conversion value when the value of the firm is very high. As it can be seen in the Figure 13, the value of a convertible bond is the maximum of its straight bond value and its conversion value, plus its option value:

Figure 13: Value of Convertible Bond



Source: Ross, Westerfield and Jaffe, Corporate Finance, 1993

1.5.3.3 Valuation of Loan Guarantees

A loan guarantee is a promise to pay any shortfall in the value of the firm that is necessary to fully repay the promised debt payment. As depicted in the figure below, if at maturity the value of the firm is less than the promised payment, $V < B$, the loan guarantee, G, will have to make up the difference between the promised

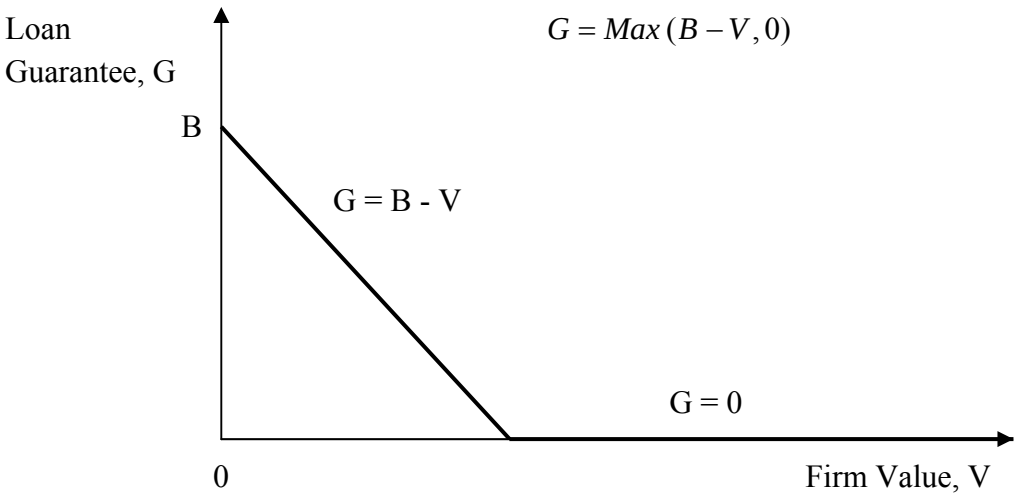
[83] Kolb, p. 570.

payment and the value of the firm, $B-V$, but if the value of the firm exceeds the promised payment, $V > B$, the guarantee will not have to pay anything i.e.:

$$G(V, 0;\ B) = Max(B - V,\ 0) \tag{15}$$

The loan guarantee is thus seen to be equivalent to a European put option on the value of the firm, V, with an exercise price equal to the promised payment B. (Figure 14). [84]

Figure 14: Value of Loan Guarantee



Source: Trigeorgis, Real Options, 1996, p.112

1.5.4 Other Option Pricing Applications in Firm Valuation

Up to now, a general review of the options approach applicable to financial claims in capital structure was covered. In proceeding sections implementation in project and firm valuation will be discussed.

Small and up-and-coming companies which are usually accepted as high-growth businesses have high flexibility and growth opportunities that could greatly

[84] Scott P. Mason and Carliss Y. Baldwin, "Evaluation of Government Subsidies to Large-Scale Energy Project: A Contingent Claims Approach," Advances in Futures and Options Research, Vol. 3, 1988, pp.169-181

enhance their cash flows. These opportunities are embedded with option value that often represents a very significant amount of the company's total value. Consequently, the new economy, neckbraking speed of globalization, particularly the innovations in internet industry has resulted in a spree of a new valuation technology that is about to be accepted as the industry standard in corporate finance.[85] Under these circumstances, it is becoming more appropriate to use a real-options-based valuation technique. But application of option pricing theory to valuation is not limited just with highly flexible high-growth companies. There are other areas that option pricing may be applied to such as valuation of natural resources, intellectual property, research and development, and joint ventures.[86] Especially, the valuation of natural resources and product patents based on real options has had a deep effect on valuation technologies in corporate finance. In the following paragraphs the areas which are mostly used for explaining real option based valuation will be discussed.

1.5.4.1 Valuation of Internet Firms

Over the past few years, financial markets are already embracing the concept of real options when valuing firms. The concept became especially popular with the arrival of internet firms at the stock markets that had no income but lots of – real or perceived – growth potential which is overlooked in traditional valuation techniques. Valuation of projects and business with growth potential must take into account the overvaluation effect they are exposed to.[87] As was stated before, the present value of a business is composed of two elements: the present value of assets in place and the growth opportunities. For companies and industries in expansion or newly created industries, significant part of the value will be captured by growth options. The most illustrative example can be captured by the impact of a tool like Internet has on growth opportunities for companies and industries.[88]

[85] Tim Coller, Marc Goedhart, and David Wessels, p. 655-657.
[86] Damodaran, Investment Valuation, pp. 375-394.
[87] Brian Kettel, Valuation of Internet and Technology Stocks, Ed. 4, Butterworth-Heinemann, Woburn, 2002, pp. 177-178.
[88] Dapena, pp. 68-69

Static valuation methods tend to undervalue investments made under uncertainty. Internet initiatives are characterized by: uncertainty of outcomes, high investments and the fact that the risk of loosing everything is real, at the same time the potential upside is huge.[89] The use of the traditional DCF model for valuation purposes will offer more problems, prompting overvaluation. Traditional valuation methods, such as DCF, are readily applied to relatively stable businesses. These methods, however, are less helpful for valuing investments that have substantial growth opportunities. These high growth ventures should be valued as options, and more specifically as real options. As long as there is some probability of success and high payoffs, investors will be willing to pay a price for such an investment even though traditional valuation may assign no value to this investment.[90]

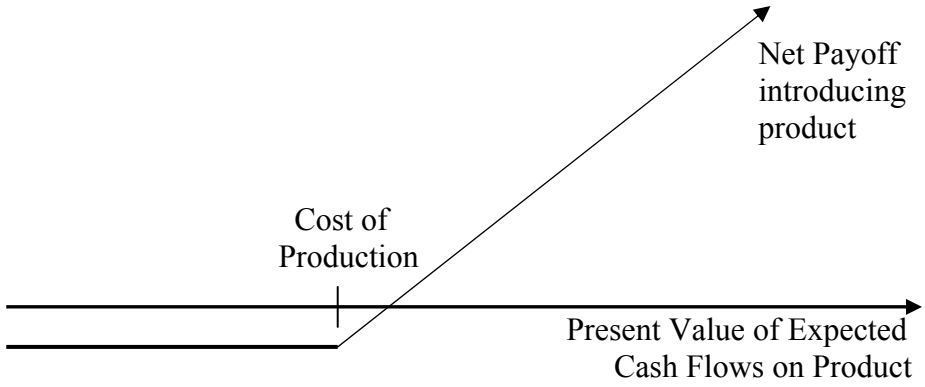
The theory of real options has been put forward as a serious alternative to traditional methods for the valuation of internet companies. Internet companies have characteristics similar to call options as they have larger potential upside and limited downside and hence a real options approach can be used to their valuation.[91] Real options approach recognizes that today's investments in projects give the investors the choice of pursuing further investments later if the climate appears to be favorable, or abandoning the investment if the economic environment is not suitable. Thus, limit the losses, but at the same time keep the doors open. In the new economy the value of the uncertainty depends upon the importance of the uncertainty to give an additional value or the growth component of the value of the firm. Traditional decision tree analysis using the constant cost capital can therefore, lead to over valuation or under valuation.[92]

[89] Briginshaw, p.188.
[90] George Athanassakos, "Valuing Internet Ventures," Journal of Business Valuation and Economic Loss Analysis, Vol. 2, No. 1, 2007, pp. 7-8.
[91] Enrico Perotti and Silvia Rossetto, "Internet Portals as Portfolios of Entry Options," University of Amsterdam and CEPR, 2000, pp. 3-4.
[92] Jyoti Gupta and Alain Chevalier, "Pertinence of Real Options Approach to the Valuation of Internet Companies," International Journal of Operational Research, Vol.2, No.2, 2002, pp. 194-195.

1.5.4.2 Valuation of Intellectual Property and Patents as Real Options

Real options analysis is designed to explicitly incorporate and analyze risk and uncertainty associated with real assets. Intellectual property (IP), whether defined in its strictest, most narrow legal sense – patents, trademarks, trade secrets, and copyrights – or more broadly to encompass all intellectual/intangible assets created from human conceptual endeavor, is the perfect representative of uncertainty, and exemplifies the real options analysis. What it does is attempt to make risk and uncertainty explicit through rational statistical means. In this way, uncertainty is bounded and risk quantified such that information becomes more clear and tangible, and the knowledge base expanded, thereby aiding decision-making.

Figure 15: Patent as a Call Option on a Product



Source: Damodaran, Investment Valuation, 2002, p.781.

Unlike financial assets, there are no existing liquid markets for intangible "real" assets. Real options analysis seeks to change that by providing a means to demystify the risk and uncertainty surrounding IP and supply potential buyers and sellers with objective, quantifiable information to shortcut uncertainty, clarify risk, and clear the path to shorter, smoother, and less costly IP deal-making. A patent can be given as an example to provide a case in point. A patent is the right, but not the obligation, to make exclusive use of an invention at a predetermined cost, for a predetermined period of time, the life of the patent. While traditional tools based on DCF analysis fails to account for the value of embedded real options as well as changes in environment before and soon after product introduction, real options

approach considers a patent asset as a contingent claim on the value of another asset.[93] A firm's patent creates an irreversible investment opportunity that individuals or other firms cannot undertake and can be viewed as a call option where the underlying asset is the product itself.[94] The firm will use the patent only if the present value of the expected cash flows from the product sales exceeds the cost of development. However, as depicted in Figure 15, if this does not occur, the firm can shelve the patent and not incur any further costs. If I, the strike price of the call option is the present value of the costs of product introduction, and V is the present value of the expected cash flows from development, the payoffs from owning a product patent can be written as:

$$\begin{aligned} \text{Payoff from owning a product patent} &= \text{V - I} \qquad \text{if V} > \text{I} \\ &= 0 \qquad\qquad \text{if V} \leq \text{I} \end{aligned} \tag{16}$$

This kind of real options application using the decision-tree and binomial-lattice methods are mostly used by biotechnology firms, for which patents play an important role.[95]

1.5.4.3 Valuation of Research and Development

A firm, which performs the R&D, cherishes a prospective future, and its R&D highly relates to its strategy. Thus measuring R&D correctly becomes quite significant. A firm that spends large quantities of money on R&D has, in general, a pessimistic NPV when it evaluates the cash flows because payoffs from R&D are highly involved with future perspectives of the project. Traditional valuation techniques for R&D (e.g., decision trees and NPV) may aggravate the fundamental problems associated with investment analysis and portfolio management, because these techniques rely solely on information that is available at the time of the analysis and cannot accurately value flexibility over time. The limitations of these

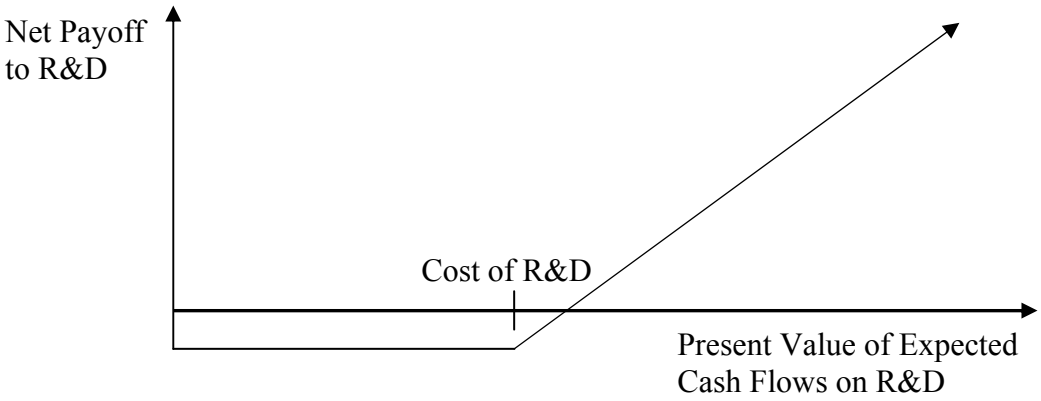
[93] Aswath Damodaran, The Dark Side of Valuation: Valuing Old Tech, New Tech, and New Economy Companies, Prentice Hall, New Jersey, 2001 (The Dark Side), pp 387-388

[94] Eduardo S. Schwartz, Patents and R&D as Real Options, Working Paper, Anderson School at UCLA, 2002, p. 4

[95] David Kellog and John M. Charnes, "Real-Options Valuation for a Biotechnology Company", Financial Analysts Journal, Vol. 56, 2000, pp. 76-84.

techniques often go unrecognized by decision-makers, resulting in suboptimal R&D investment decisions. Myers was the first who proposed to apply the options pricing theory to the valuation of R&D. He affirmed that "the value of R&D is almost all option value".[96] Therefore, it is not useful to rely on traditional evaluation tools, which may lead to the strategic error decisions due to the "over-discounting" of highly uncertain projects.

Figure 16: Payoff from R&D



Source: Damodaran, The Promise and the Peril of Real Options, 2001.

A new product potentially generated by R&D can be valued as a call option illustrated as in Figure 16, where the product generated by R&D is the underlying asset. The expense spent on R&D is the strike price of the call option. The new project coming up from R&D provides the payoffs for the firm. In general, the R&D yields high returns since it is of high-risk industry.

$$\text{Payoff from owning a product generated by R\&D} \quad \begin{cases} = V - I & \text{if } V > I \\ = 0 & \text{if } V \le I \end{cases} \qquad (17)$$

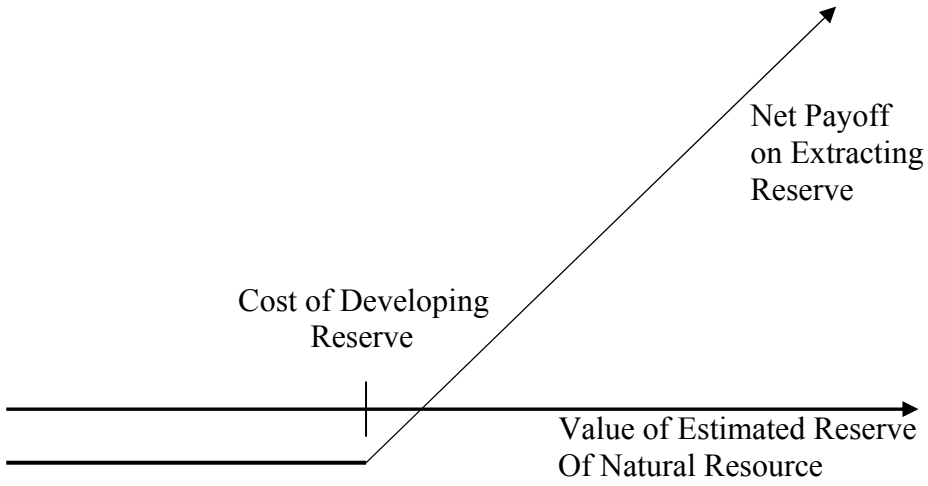
where V is the present value of expected cash flow from R&D, I is the costs of R&D.[97]

1.5.4.4 Valuation of Natural Resource Firm

[96] Stewart C. Myers, "Capital Structure Puzzle," Journal of Finance, Vol. 39, No. 3, 1984 (Capital Structure), pp. 575-592
[97] Damodaran, The Promise and the Peril, p.58.

It was Brennan and Schwartz who first developed a one-factor model for evaluating natural resource investments. Their model for the evaluation of investment projects treated output prices as stochastic, not static as it is taken in traditional techniques, making it particularly suitable for analyzing natural resource investment projects, where uncertain prices are a particular concern.[98] Firms that make natural resource investments have the option to leave the investments untouched if the price of the resource is low and to exploit them fully when the price rises. Therefore, the reserves are extracted if and only if the value of the asset extracted exceeds the cost of the development. (Figure 17).

Figure 17: Natural Resource as a Call Option



Source: Damodaran, 2002, Investment Valuation, p. 788.

Defining the cost of development as X, and the estimated value of the resource, which depends on the estimated quantity and the price of the resource, as V. The potential payoffs on a natural resource option can be written as follows: [99]

$$\text{Payoff on natural resource investment} = V - X \quad \text{if } V > X \qquad (18)$$
$$= 0 \quad \text{if } V \leq X$$

Thus, the investment in a natural resource option has a payoff function similar to a call option. As a real-world-example the work of Moel and Tufano can

[98] Brennan and Schwartz, pp. 135-137.
[99] Damodaran, The Promise And The Peril, pp. 37-40.

be given. They study the bidding for a copper mine. The mine itself had a valuable real option component, in the form of the right to develop the mine after completing the exploration. Real options analysis used by them incorporates managerial flexibility, which is, in their study, the option to abandon the project if the result of exploration turns out to be negative. [100]

1.5.4.5 Valuation of Joint Ventures as Real Options

The real options perspective has generated insights into a variety of business practices that engage with investments in new projects characterized by uncertain outcomes. Recently, this viewpoint has been implemented in explaining various issues related to joint ventures (JV). The real options approach basically enables decision makers understand the value of flexibility that is either lost or gained due to a particular strategic decision. In context of joint venturing, the strategic decision is the formation of the joint venture, which can enhance as well as constrain managerial flexibility. The flexibilities that may be created through a JV incorporate, particularly, the option to acquire the partner's stake or divest ones' stake to the partner, the option to expand or contract the venture, and option to utilize knowledge gained from the JV. [101]

A joint venture serves as a way to bridge option of waiting to invest, whereby it pays to wait before committing resources and option of expanding production, investment commitment is necessary in order to have the right to expand in the future, through pooling resources of two or more firms. Because the value of the option to expand is greatest in new markets and technologies, any given firm is unlikely to possess the full repertoire of skills.[102] A joint venture not only shares the investment burden, but sometimes reduces it, as the parties may bring different skills, thereby lowering the total investment cost. In this sense, a joint venture resolves

[100] Alberto Moel and Peter Tufano, "Bidding for the Antamina Mine: Valuation and Incentives in a Real Options Context," Working Paper, Monitor Corporate Finance, Monitor Group, Cambridge, MA and Harvard Business School, Boston, MA, 1998, pp. 7-18.
[101] Tailan Chi and Anju Seth, Joint Ventures through a Real Options Lens, Ed. Farok J. Contractor and Peter Lorange, Cooperative Strategies and Alliances, Pergamon, Oxford, 2002, pp. 71-75.
[102] Ulrich Pape and Stephan H. Schmidt-Tank, "Valuing Joint Ventures Using Real Options," ESCP-EAP Working Paper No. 7, September 2004, pp. 14 -16.

partly the tradeoff between buying flexibility now and waiting to invest and focus later.[103] Joint ventures are investments, which bring firm the asymmetry – to discretionally expand in favorable environments while to avoid some of the losses from downside risk. This asymmetry supports strongly that joint ventures are designed as options.[104]

When the market for the technology or new product is proven, the option to acquire, condition when one firm purchases the remaining shares in the venture, is likely to be exercised. Through the joint venture, the buying party has acquired the skills of the partner firm and no longer needs to invest in the development of the requisite capability to expand into the targeted market. The divesting firm is willing to sell because, one, it realizes capital gains, and two, it may also not have the downstream assets to bring the technology to market.[105]

1.6 STOCKS IN THE CONTEXT OF REAL OPTIONS

This section turns attention to the major topic of the thesis and bridges the notion of real options with for the following chapters. Application of real options analysis to the valuation of stock market equities where growth potential is significant will be discussed briefly.

When the technology boom was on its peak, most analysts used real options to value stock of companies that had growth potential such as internet and biotech stocks. Acquiring shares of a dot.com company was similar to buying an option on the many ways the company might grow in the future. Company's decision to enter a new line of business is analogical to exercising a call option.

The main idea is that a growth company can be considered as a portfolio of real options, the value of which represents opportunities in business operations. By

[103] Birger Wernerfelt and Aneel Karnani, "Competitive Strategy under Uncertainty," Strategic Management Journal, Vol. 8, 1987, pp. 187-194.
[104] Sung Min Kim and Anju Seth, Valuation of International Joint Ventures: A Real Options Approach, Ed. Farok J. Contractor, Valuation of Intangible Assets in Global Operations, Westport, 2001, pp.158-161.
[105] David J. Teece, "Profiting from Technological Innovation: Implications for Integration, Collaboration, Licensing and Public Policy," Research Policy, Vol. 15, 1986, p. 300.

incorporating future possible outcomes into the stock price's information, real options can be a more sophisticated alternative to traditional DCF analysis, which is, if not seriously modified, understate true investment potential because of the failure to take into consideration the tactical flexibility and value-creating upside potential maintained by additional investments. Market analysts who use traditional valuation techniques assume that businesses that possess real options are extremely volatile because of the risk in their known operations. Consequently, costs of capital used in their discounted cash flow models will be higher. This would end up discount rates suggested by the Capital Asset Pricing Model, which relies heavily on beta, greatly overstating the risk of the core investments of businesses with real options. More reasonable valuations for embedded options can be reached if the appropriate discount rates in valuing the known businesses are used. [106]

But the enrichment of the base case DCF valuation by incorporating real options analysis needs to be approached with the supreme caution. [107] Some companies may possess a range of real options, and strategic thinking may be enhanced by reference to real options ideas. In stock market context, real option value may be imputed from the fact that the stock market value may exceeds the estimated equity value of the existing businesses of the company. This estimated value calculated by a discounted cash flow analysis of assets in place, which excludes growth opportunities, gives a fundamental value of operations. In such circumstances, the difference between firm's unbiased fundamental value of assets in place based on a DCF valuation and its stock market value is usually termed market-imputed real options value. [108] After adjusting for surplus assets that the firm may posses and also for the value of debt that the company owes, it comes out that the total fundamental value would be equal to fundamental value of assets in place plus present value of growth opportunities, while stock market value would be the sum of fundamental value of assets in place and market - imputed real option value.

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[106] Michael J. Mauboussin, "Get Real – Using Real Options in Security Analysis," Credit Suisse First Boston Corporation Equity Research, June 23, 1999, p.15

[107] Adrian Buckley et al., "Stock Market Valuation with Real Options: Lessons from Netscape," European Management Journal, Vol. 20, No. 5, October 2002, pp. 513.

[108] Alfred Rappaport and Michael J. Mauboussin, Expectations Investing, Harvard Business School Press, MA, 2001, p.126.

Obviously, if markets were efficiently pricing stocks, stock market value would be equal to total fundamental value and market-imputed real options value would be equal to the present value of growth opportunities. In fact, the directors sometimes may not choose to announce to financial markets the growth opportunities companies have, possibly because of the caution that competitors would made unfavorable responses if growth opportunities were communicated to the public. In addition, financial markets do not always value stocks correctly and this is confirmed by the increasing evidence of deviation from efficient markets.

CHAPTER II

ASSET PRICING MODELS AND STOCK MARKET ANOMALIES

2.1 ASSET PRICING MODELS

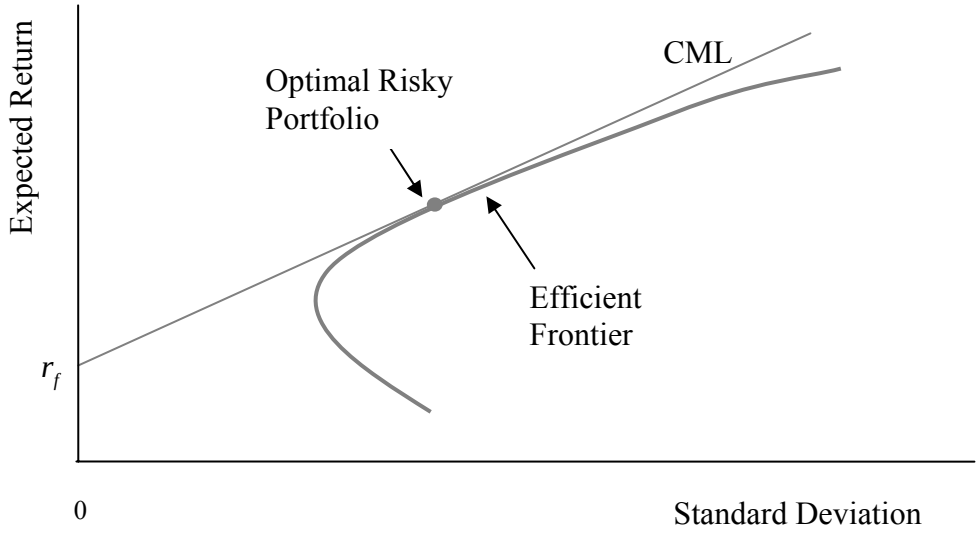
In stock market, the pricing function has been considered important and a subject of extensive research. In the literature, behavior of stock market has been studied by employing asset pricing models such as Capital Asset Pricing Model (CAPM), the Conditional CAPM, the Arbitrage Pricing Theory (APT), Intertemporal CAPM, Consumption based CAPM, and Three Factor Model (TFM). In the following sections, a short review of portfolio theory, which is the cornerstone of aforementioned models, will be given first and explanation for each of these models will be given.

2.1.1 The Portfolio Theory

According to mean-variance assumptions, a risk-averse investor's utility increases with the mean and declines with the return variance of total portfolio.[109] While the mean is the expected return on the portfolio, the variance is the indicator of the portfolio's total risk. The efficient frontier describes optimal set of portfolios which have the highest expected return for each given risk level of portfolio return measured by the variance of returns. Accordingly, modern portfolio theory says that by choosing a portfolio on the efficient frontier, an investor maximizes expected utility as shown in Figure 18.[110] It was Harry Markowitz, who developed optimization techniques for deriving the efficient frontier of risky assets in 1952. He used estimated values of expected return, standard deviation of return, and pairwise covariances or correlations for the given risky securities as inputs to derive efficient frontier.[111]

[109] John Long, "Stock Prices, Inflation, and the Term Structure of Interest Rates," Journal of Financial Economics, Vol. 1, No. 2, 1974, pp. 131-170.
[110] Zvi Bodie, Alex Cane and Alan J. Marcus, Investments, Ed. 6, International Edition, McGraw-Hill, New York, 2005, p.284.
[111] Harry M. Markowitz, "Portfolio Selection," Journal of Finance, Vol. 7, No. 1, 1952, pp. 77–78.

Figure 18: The Efficient Frontier and Capital market Line



Source: Bodie, Cane and Marcus, Investments, 2005, p.284.

Portfolio selection problem of an investor is simplified by the availability of a risk-free asset, r_f. Due to the opportunity to invest in both risky and risk-free assets, all efficient portfolios will be combinations of the risk-free asset and a unique "tangency" portfolio of the risky assets. Relatively more risk-averse investors are supposed to invest a larger fraction of their assets in the risk-free asset, while investors with relatively more risk-tolerance will prefer to hold a greater fraction of their investment in the tangency portfolio. All of these optimal combinations of the tangency portfolio and the risk-free asset lie on a straight line when expected return is plotted against standard deviation of return. This line, called "the Capital Market Line (CML)," is the efficient frontier and represents the best possible combinations of portfolio expected return and standard deviation.[112]

[112] S.P. Kothari and Jay Shanken, "Anomalies and Efficient Portfolio Formation," CFA Institute Publications: Research Foundation Publications, December 2002, pp.2-5.

2.1.2 The Capital Asset Pricing Model

The CAPM of Sharpe[113] and Lintner,[114] which is one of the fundamental subjects in financial theory, marks the birth of APT, later resulting in a Nobel Prize for Sharpe in 1990. This technique, built on Markowitz's portfolio ideas, simplifies an investor's optimal portfolio decision and determines appropriate required rate of return of an asset. The main critical assumptions behind the CAPM is that investors have homogenous expectations, which means that identical beliefs about securities' expected returns, standard deviations, and pairwise covariances are shared by all market participants. With similar expectations and the same range of interests about investment, all investors eventually arrive at the same efficient frontier. Thus, all of them should hold combinations of the same tangency portfolio and asset at the risk-free rate. Since assets demanded by all investors must equal the supply, the tangency portfolio in equilibrium is the value-weighted portfolio of all risky assets in the economy, also referred as the market portfolio.

The CAPM is a one period, ex-ante model, which predicts that a market portfolio of invested wealth is mean-variance efficient resulting in a linear cross-sectional relationship between mean excess returns and exposures to the market factor.[115] Especially, the theory implies that expected return is an increasing linear function of its covariance risk, or beta (β). Where β is defined as:

$$\beta_i = \frac{\operatorname{cov}(R_i, R_m)}{\operatorname{var}(R_{mi})} \tag{19}$$

where $\operatorname{cov}(R_i, R_m)$ is the covariance of security *i*'s return with the return on the market portfolio, $\operatorname{var}(R_{mi})$ is the variance of the return on the market portfolio. Beta

[113] William F. Sharpe, "Capital Asset Prices - A Theory of Market Equilibrium Under Conditions of Risk," Journal of Finance, Vol. 19, 1964, pp. 425-27

[114] John Lintner, "Security Prices, Risk, and Maximal Gains from Diversification," Journal of Finance, Vol. 20, 1965, pp. 587-590.

[115] Eugene F. Fama and Kenneth R. French, "The Cross-Section of Expected Stock Returns," Journal of Financial Studies, Vol. 47, 1992 (The Cross Section), p. 427.

is the sensitivity of security *i* to aggregate market movements and measured by a slope coefficient in the regression of *i*'s returns on that of the market portfolio.

The CAPM linear risk-return relationship is:

$$E(R_i) = R_f + \beta_i\left[E(R_m) - R_f\right] \tag{20}$$

where $E(R_i)$ is security *i*'s expected rate of return, R_f is the risk-free rate of return, and $\left[E(R_m) - R_f\right]$ is the market risk premium.

2.1.3 The Conditional Capital Asset Pricing Model

As was explained in the previous sections, the traditional CAPM, which describes stock return solely on β measure, is based on the assumption that all market participants share identical subjective mean-variance expectations of return distribution, and portfolio decision is solely based on these moments. But empirical evidence suggests there is a deviation of the model from its formal theory. The simple, unconditional CAPM does not describe the cross sectional pattern of average stock returns. Mainly, the CAPM does not explain why small stocks outperform large stocks, why firms with high book-to-market (BV/MV) ratios outperform those with low BV/MV ratio, known as value effect, or as to why there is momentum effect, which occurs when stocks with high returns in the previous year continue to outperform those with low prior returns.[116]

Return distribution has been observed that it varies over time. In other words, the stock return distribution is time variant in nature and consequently, the subjective expectation of moment[117] differ according to different periods. This entails that,

[116]Jonathan Lewellen and Stefan Nagel, "The Conditional CAPM Does not Explain Asset-pricing Anomalies," Journal of Financial Economics, Vol. 82, 2006, pp. 289.

[117] First moment is the mean. Alternative estimators for the first moments are the median and the mode. While variance is the second moment, the skewness and the kurtosis of a distribution are the third moment and the fourth moments respectively. (William H. Press, Saul A. Teukolsky, William T. Vetterling and Brian P. Flannery, Numerical Recipes in C: The Art of Scientific Computing, Cambridge University Press, Cambridge, 1992, p. 611).

contrary to what is assumed in the traditional CAPM for stock returns, the investor expectations of moments behave like random variables rather than stable.[118]

The Conditional CAPM states that the expected return of an asset is related to their sensitivity of changes in the state of the economy, referred as the time series of betas for each state of economy.[119] For each relevant state there is market price or premium[120] per unit of beta. The business cycle variables are major determinants of price movements of stocks. At business-cycle troughs, investors are short of cash and use all their cash to keep consumption at permanent level. Consequently the equity risk premium becomes high. The risk premium must be high in equilibrium so that investors hold their portfolio of stocks.

To estimate beta risk month by month, the lagged business cycle variables are entered into model in linear form. The model and conditional variance and covariance of economic risks are estimated month by month using business cycle variables, allowing the time variation. In the empirical literature many sources of variability of beta and price of beta were given. [121, 122]

The main proposition while taking care of time varying moments in CAPM is that the investors still share identical subjective expectations of moments but these moments are conditional on the information at the time *t*. In symbols the simplest conditional version of CAPM proposed by Sharpe, [123] hereafter referred as Conditional CAPM, can be written in the form of equation 21:

[118] Tim Bollerslev, "Generalized Autoregressive Conditional Heteroskedasticity," Journal of Econometrics, Vol. 31, 1986, pp. 307-308.
[119] Tano Santos and Pietro Veronesi, "Labor Income and Predictable Stock Returns," National Bureau of Economic Research, Inc Working Paper No. 8309, May 2001, pp. 1-2.
[120] Attiya Y. Javid and Eatzaz Ahmad, "The Conditional Capital Asset Pricing Model: Evidence from Karachi Stock Exchange," Pakistan Institute of Development Economics Working Papers, 2008, No. 48, pp. 13-14.
[121] Sanford Jay Grossman, "Further Results on the Informational Efficiency of Stock Markets," Journal of Economic Theory, Vol. 18, No. 1, 1978, pp. 81-101.
[122] Peter Bossaerts and Richard C. Green, "A General Equilibrium Model of Changing Risk Premium: Theory and Tests," Review of Financial Studies, Vol. 2, 1989, pp. 467–494.
[123] William F. Sharpe, "Capital Asset Pricing Theory of Market Equilibrium Under Conditions of Risk," Journal of Finance, Vol. 19, 1964, pp. 432-433.

$$E\left(R_{it+1}\middle|Z_t\right)=\gamma_0\left(Z_t\right)+\beta_{imt}\,E_{t-1}\gamma_m\left(Z_t\right) \tag{21}$$

where R_{it+1} is the rate of return of asset i between times t and $t+1$, and β_{imt} is the market beta at time t. The market beta is the conditional covariance of the return with the market portfolio divided by the conditional variance of the market portfolio; that is the slope coefficient in a conditional regression of the asset return on that of the market is conditional on the information at time t. The term Z_t is conditioning information, assumed to be publicly available at time t. The term $\gamma_m\left(Z_t\right)$ represents the risk premium for the market beta, and $\gamma_0\left(Z_t\right)$ is the expected return of all portfolios with market betas equal to zero. If there is risk-free asset available at time t, its rate of return equal to $\gamma_0\left(Z_t\right)$.[124]

The Conditional CAPM does not explain asset pricing anomalies like BV/MV or momentum. Analytically, if the conditional CAPM holds, deviations from the unconditional CAPM depend on the covariances among betas, the market risk premium, and market volatility. Jonathan Lewellen and Stefan Nagel argue that, for plausible parameters, the covariances are simply too small to explain large unconditional pricing errors. The pricing errors induced by time-varying betas might not be large enough to explain important asset-pricing anomalies.[125]

2.1.4 The Intertemporal Capital Asset Pricing Model (ICAPM)

The main assumption in Markowitz portfolio optimization and the original CAPM is that decisions made by individuals are for only one time period, but in reality investors can rebalance their portfolios on a regular basis. In single period models, it is assumed that the accrued wealth will be consumed at the end of the period. In multiperiod context on the other hand, model is oriented towards the

[124] Wayne E. Ferson, Chapter 9, Conditional Asset Pricing, ed. Cheng F. Lee and Alice C. Lee, Encyclopedia of Finance, Springer, New York, 2006, pp. 377-378.
[125] Lewellen and Nagel, pp. 310.

optimal intertemporal consumption.[126] In order to construct a framework that is both more realistic and at the same time more tractable than the discrete time model, Merton has constructed a generalized Intertemporal Capital Asset Pricing Model (ICAPM), in which factors other than market uncertainty are priced. These factors, known as state variables, are the major sources of uncertainty that affects the individual's consumption plan. Merton's examples of state variables are a person's income, the relative prices of consumption goods, the one-period rate of interest and the return on the market portfolio. According to ICAPM individuals solve their lifetime consumption decision in a multi-period setting.[127]

One of Merton's key results was that in a dynamic setting, the static CAPM does not in general hold.[128] In particular, Merton demonstrates that an agent's welfare at any point in time depends not only on his own wealth, but the state of the economy as well. Even if the level of wealth is the same, but the economy is doing well then the agent's welfare will be greater than if it is doing badly. Thus the demand for risky assets will depend on the covariance of asset with the market, as in Markowitz' static portfolio optimization problem, but also on a demand to hedge adverse shocks to the investment opportunity set. To reduce uncertainty investors will try to hold hedging assets with negative covariance towards a change in the state variable. As expected, the demand for these hedging assets will be high, which in turn raises price, while reducing their return. On the other hand assets that have positive correlation with the sate variable need to have a risk premium.

Merton's model would imply that the expected return-beta relationship of the single-factor CAPM would be generalized to the following relationship: [129]

$$E_t\left(R_{i,t+1}\right) = \underbrace{R_{ft} + \beta_{i,R_m}\left[E_t\left(R_{m,t+1}\right) - R_{ft}\right]}_{\text{Similar to CAPM}} + \sum_{h=1}^{H} \beta_{i,R_h}\left[E_t\left(R_{h,t+1}\right) - R\right] \qquad (22)$$

[126] Manuel Kürschner, "Limitations of the Capital Asset Pricing Model: Criticism and New Developments," Scholarly Research Paper, University of Cooperative Education, 2008, p.14.
[127] Seth Armitage, The Cost of Capital, Cambridge University Press, New York, 2005, p. 82.
[128] Robert C. Merton, "An Intertemporal Capital Asset Pricing Model," Econometrica, Vol. 41, 1973 (ICAPM), pp. 867-887.
[129] Armitage, p.84.

where H represents different hedging assets, R_h is the rate of return of the hedging portfolio that best hedges state variable uncertainty, β_{i,R_h} is the sensitivity to hedge portfolio $h, E_t\left(R_{h,t+1}\right) - R_{ft}$ is the risk premium associated with the exposure to the state variable.

2.1.5 The Consumption-based Capital Asset Pricing Model

Different variables were used in the models in order to determine the risk and return of assets, such as the market situation or state variables mentioned above. In Consumption based Capital Asset Pricing Model (CCAPM), developed independently by Lucas[130] and Breeden[131] on the other hand, the focus is directly on modeling the marginal utility of consumption.[132] The CCAPM is a more general asset pricing framework than the standard mean-variance CAPM. In this model, investors do not base their behavior on the one-period mean and standard deviation of returns as in the CAPM, but the model is intertemporal in a sense that investors are assumed to maximize expected intertemporal utility of current and future consumption. Breeden showed that assets are valued by their marginal contribution to future consumption and not wealth. As in the traditional CAPM, CCAPM allows assets to be priced with a single beta. In contrast to the latter the CCAPM's beta is measured not with regard to aggregate market wealth, but with regard to an aggregate consumption flow. This model explicitly formulates a utility-maximization problem of an agent under a budget constraint which reflects the trade-off between investment in assets and consumption.[133] Equilibrium expected returns are proportional to their "consumption beta." This contrast with the market oriented

[130] Robert E. Lucas, "Asset Prices in an Exchange Economy," Econometrica, Vol. 46, No. 6, 1978, pp. 1429-1445.
[131] Douglas T. Breeden, "An Intertemporal Asset Pricing Model with Stochastic Consumption and Investment Opportunities," Journal of Financial Economics, Vol. 7, No. 3, 1979, pp. 265-296.
[132] The addition to an individual's utility from a small increase in consumption of any good, per unit of the increase. It is usually assumed that, at least beyond a certain point, the marginal utility of any particular good decreases as more is consumed (Oxford University Press: A Dictionary of Economics: John Black, 2003).
[133] René Böheim and Michael Boss, "Consumption Based Capital Asset Pricing and the Austrian Stock Exchange," Economic Series, Institute for Advanced Studies, No 29, May 1996, p. 2.

CAPM.[134] As a result, each asset's risk is completely specified by the covariance of its return with the change in aggregate consumption.[135]

Simplified CCAPM can be descried as follows:[136]

$$E_t\left(R_{i,t+1}\right) = R_f + \beta_{i,\Delta C}\left[E_t\left(\Delta C_{t+1}\right) - R_{ft}\right] \tag{23}$$

where $\beta_{i,\Delta C}$ is the sensitivity towards change in consumption, ΔC is the change in consumption, $E_t\left(\Delta C_{t+1}\right) - R_{ft}$ is the consumption premium.

In the CCAPM, financial assets allow the consumer to smooth investor's consumption pattern over time, selling assets to finance consumption in "bad" times and saving in "good" times. Assets whose returns have high negative conditional covariance with consumption will be willingly held even though they have low expected returns. This is because they can be sold at a time when they are most needed, namely when consumption is low, and, therefore, extra consumption yields high marginal utility.[137]

Unfortunately, Consumption-based Asset Pricing Models prove disappointing empirically.[138] In empirical applications the return on the asset perfectly correlated with consumption is usually taken to be the growth rate of consumption which is more easily observable. However, the CCAPM operationalized in this way does not perform well. One reason might be the fact that observed consumption is not similar enough to the theoretical concept of consumption. It is difficult for instance to measure the stream of durable good consumption services during one period. It is certainly not equal to the amount currently spent on consumer durables. The

[134] Douglas T. Breeden, Michael R. Gibbons and Robert H. Litzenberger, "Empirical Test of the Consumption-Oriented CAPM," Journal of Finance, Vol. 44, 1989, p. 232-235
[135] Robert C. Merton, Continuous Time Finance, Blackwell Publishers, Cambrigde, 1993 (Continuous Time Finance), p. 520.
[136] Kürschner, p.15.
[137] Keith Cuthbertson, Quantitative Financial Economics: Stocks, Bonds and Foreign Exchange, John Wiley & Sons, Chichester, 1996, pp. 76-77.
[138] John Y. Campbell and John H. Cochrane, "Explaining the Poor Performance of Consumption-Based Asset Pricing Models," The Journal of Finance, Vol. 55, No. 6, 2000, p. 2863.

empirical work of Mankiw and Shapiro shows that in a cross-sectional regression, the market beta clearly outperforms the consumption beta in explaining the cross-sectional variation in returns.[139]

2.1.6 The Arbitrage Pricing Theory

Because the existing simple theoretical models can not fully explain the actual pricing of risky assets, researchers attempted to explain the pricing regularities within the framework of another, relatively simple theoretical model, the Arbitrage Pricing Theory (APT). It was offered by Ross as a potential successor to the CAPM.[140] This theory permits the pricing of multiple sources of risk without specifying the number of risk factors or identifying what they really are.[141]

Arbitrage is another way of minimizing risk and by simultaneously buying and selling different assets that have highly correlated returns. In view of that, the derivation of the APT does not require the existence of an efficiently diversified market portfolio. As a result, more than one index can be used to explain returns. The form of the APT is similar to the CAPM, except that it includes more explanatory variables with a different beta for each index:

$$E(R_i) = R_f + \beta_{i,1}\lambda_1 + \beta_{i,2}\lambda_2 + \cdots + \beta_{i,n}\lambda_n \tag{24}$$

where R_f is the risk-free rate, $\beta_{i,j}$ is the security i's "beta" for risk factor j $(j = 1, 2, 3, ..., n)$, λ_j is the premium risk factor j.

It can be seen that if $\lambda_1 = \lfloor E(R_m) - | R_f \rfloor$ and all the other $\lambda_j = 0$, then the APT reduces to the traditional CAPM. In this way, the CAPM becomes a special

[139] N. Gregory Mankiw and Matthew D. Shapiro, "Risk and Return: Consumption Beta versus Market Beta," Review of Economics and Statistics, 1986, pp. 456-458.
[140] Stephen A. Ross, ''The Arbitrage Theory of Capital Asset Pricing," Journal of Economic Theory, Vol. 13, 1976, pp. 341–360.
[141] Marc Reinganum, "What the Anomalies Mean," The Journal of Finance, Vol. 39, No. 3, 1984 (Anomalies), pp. 437-438.

form of the APT.[142] For instance, the APT makes no assumptions regarding the empirical distribution of asset returns and no strong assumptions about individuals' utility functions other than greed and risk aversion, the requirement of assumptions makes APT more robust than the CAPM. Moreover as compared to CAPM, the APT applies to any subset of assets and there is no requirement for a market portfolio embracing the entire universe of assets. Since it does not depend upon the existence of an efficiently diversified market, the APT manages to avoid Roll's most important criticism of the CAPM. Roll argues that tests performed with any portfolio other than the true market portfolio are not tests of the CAPM. He tested if the portfolio chosen as a proxy for the market is efficient or not and says that it is difficult to identify true market portfolio.[143]

2.1.7 The Fama and French Three Factor Model

Additional factors that provide explanatory power other than β for average stock returns were identified in several studies during the 1980's. Variables that have no special standing in APT showed reliable power in explaining the cross sectional pattern of stock returns. So far there is no agreed upon model to replace CAPM. However, the Three Factor Model (TFM) offered by Fama and French is thought to be the most well known model in the current finance literature. Since its appearance in the financial literature, the Fama-French TFM has become one of the dominating models in empirical asset pricing.

While conventional Capital Asset Pricing Model states that the firm's expected rate of return is related to the term premium of the riskless interest rate and the risk premium of the market, the Three Factor Model takes a different approach in explaining market pricing by relating expected rate of return to three separate risk factors rather than just one. Based on the results of widely quoted test of market efficiency previously made by them and the logic behind the APT, Fama and French, in addition to the market excess return as in the CAPM, add the size and book-to-

[142] Broyles, p. 240.
[143] Richard Roll, "A Critique of the Asset Pricing Theory's Tests," Journal of Financial Economics, Vol. 4, 1977, pp.129-176.

market factors in their model. They find that these two factors explain the differences in the average cross section returns of stocks: value stocks have provided much better return than growth stocks and small stocks have provided much better return than that of large stocks over time and around the world. [144] After analyzing the results of the test made, they came to a conclusion that stock exchange markets are informational efficient and that the TFM, as compared to CAPM, has a higher explanatory power.[145]Another implication that makes TFM different from CAPM is that investors must decide how much of each of the three factors they are willing to hold when they construct their portfolios. They must manage the tradeoffs between the three factors to suite their own appetite for the various risks, while under CAPM the ultimate equity portfolio is the global portfolio.

The basic idea of Fama and French is that the expected return on a portfolio in excess of the risk free rate is explained by the sensitivity of its return to three factors such as the excess return on a broad market portfolio (β), the difference between the return on a portfolio of small stocks and the return on a portfolio of large stocks (SMB) and finally the difference between the return on a portfolio of high-book-to-market stocks and the return on a portfolio of low book-to-market stocks (HML). The model is as follows: [146]

$$E(R_i) - R_f = \alpha_i + \beta_i \left[E(R_m) - R_f \right] + s_i E(SMB) + h_i E(HML) + \varepsilon_i \qquad (25)$$

where: $E(R_i)$ is the expected stock return;

R_f is the risk-free rate;

$E(R_m)$ is the expected return of market portfolio;

$E(SMB)$, small minus big, is the difference between the equally weight averages of the returns on the three small stock portfolios and the three big stock portfolios;

[144] Stefan Koch and Christian Westheide, "The Conditional Relation between Fama-French Betas and Return," University of Bonn Working Paper Series, February 15, 2008, pp. 1-2**.**

[145] Eugene Fama and Kenneth French, "Multifactor Explanations of Asset Pricing Anomalies," Journal of Finance, Vol. 51, No. 1, 1996 (Multifactor Explanations), p. 69.

[146] Eugene Fama and Kenneth French, "Common Risk Factors in the Returns on Stocks and Bonds," Journal of Financial Economics, Vol. 33, No. 1, 1993 (Common Risk Factors), pp. 4-5.

$E(HML)$, high book to market minus low book to market, is the difference between the return on a portfolio of high book to market stocks and the return on a portfolio of low book to market stocks, sorted be neutral with respect to size;

β_i : is the coefficient loading for the excess return of the market portfolio over the risk-free rate;

s_i is the coefficient loading for the excess average return of portfolios with small equity class over portfolios of big equity class;

h_i is the coefficient loading for the excess average returns of portfolios with high book-to-market equity class over those with low book-to-market equity class;

ε_i is the error term for portfolio. [147]

It can be seen that the Fama and French three-factor model is more like an extended version of the CAPM. In addition to the market factor, it includes the two factors such as firm size and book-to-market equity (BE/ME).[148] In fact, the model supplements the CAPM model by adding additional factors: the size effect and the book-to-market equity effect. The size effect is the empirical anomaly that firms with small market capitalization exhibit returns that on average significantly exceed those of large firms. The book-to-market equity effect, also known as value premium, shows that average returns are greater the higher the book-to market-value ratio (BE/ME) and vice versa. These variables explain average return differences across portfolios that cannot be accounted for by beta alone. Fama and French have interpreted their TFM as evidence for a distress premium. Small stocks with high book-to-market ratios are firms that have performed poorly are vulnerable to financial distress, and hence investors command risk premium. [149] In the next chapter detailed possible explanations for the size and book-to-market equity effects along with calendar anomalies will be covered in more depth.

[147] Souad Ajili, "Capital Asset Pricing Model and Three Factor Model of Fama and French Revised in the Case of France," Biblioteca Digital da FGV, 13.05.2008, http://hdl.handle.net/10438/1181 (06.07.2009), pp. 4-5.
[148] Fama and French, The Cross-Section, pp. 427-29.
[149] Fama and French, Multifactor Explanations, p. 77-80.

Even though the model is an empirical success, it lacks a satisfactory understanding of the underlying risk reflected in security returns. The inclusion of these two accounting-based variables into the CAPM can not provide enough reasons as to why size and value effects can cause the realized abnormal stock returns. Fama and French say in their underlying study that "without a theory that specifies the exact form of the state variables or common factors in returns, the choice of any particular version of the factors is somewhat arbitrary"[150]

2.2 EFFICIENT MARKET HYPOTHESIS

> *"If the market, in effect, does not predict its fluctuations, it does assess them as being more or less likely, and this likelihood can be evaluated mathematically*"
>
> Louis Bachelier, 1900

Market efficiency has been one of the central topics discussed both in finance and in economics. Clearly, market efficiency is a concept that is controversial and attracts strong views both pro and con, partly because of differences in individuals' perceptions about what it really means, and partly because of the fact that it is a core belief that mainly determines how an investor approaches investing. The word efficiency is used in several contexts as internally efficient markets and externally efficient capital markets. In internally efficient markets, known also as operational efficient market, an investor can obtain transaction services as cheaply as possible, given the cost associated with furnishing those services. The second approach to define market efficiency, pricing efficiency is the one finance capitalizes on, thus in this thesis the term to mean this approach will be used. Pricing efficiency refers to a market where prices at all time reflect all available information that is relevant to the

[150] Fama and French, Common Risk Factors, p. 53

valuation of securities. That is, relevant information about the security is quickly integrated into the prices of securities.[151]

2.2.1 The Theory of Speculation

It was Bachelier who first anticipated the concept of market efficiency in his dissertation submitted for PhD in mathematics. In the first paragraph of his thesis, Bachelier writes that "past, present and even discounted future events are reflected in market price, but often show no apparent relation to price changes".[152] In his doctoral thesis he derived the Theory of Speculation, a theory that speculative prices follow random walks, which was based on the assumption of zero expectation of gain. By comparing the statistical distribution of price behavior expected from this theory with observed price changes distributions of some government commodities, he found a close relation between the observed distribution and distribution expected from the theory, and concluded that "the mathematical expectation of the speculator is zero".[153]

2.2.2 Random Walk Theory

Random walk is a stock market theory that states that future steps or directions cannot be predicted on the basis of past actions. When the term is applied to the stock market, it means that short-run changes in stock prices cannot be predicted. Investment advisory services, earnings predictions, and complicated chart patterns are useless. [154] The theory, first mentioned by Maurice Kendall, states that stock price fluctuations are independent of each other and have the same probability distribution, but that the prices maintain an upward trend in the long run.[155]

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[151] Frank J. Fabozzi and Miller Modigliani, Capital Markets: Institutions and Instruments, Secondary Markets, Pearson Education, New Jersey, 2003, p. 116.
[152] Peter L. Bernstein, Capital Ideas: The Improbable Origins Of Modern Wall Street, Simon & Schuster Adult Publishing Group, New York, 1993, p.19.
[153] Louis Bachelier, Théorie de la Spéculation, Gauthier-Villars, 1900, translation of James Boness, Theory of Speculation, ed. Paul Cootner, The Random Character of Stock Market Prices, MIT Press, Cambridge, 1964, p. 28.
[154] Burton Malkiel, A Random Walk Down Wall Street, Norton & Company, New York, 1999, p.24.
[155] Maurice Kendall, "The Analysis of Economic Time-Series - Part I: Prices," Journal of the Royal Statistical Society, Series A (General), Vol. 116, Pt. 1, 1953 (Random Walk), pp.16-17.

The main idea behind the random walk is that the prices change over time, and follows a random path and can not be predicted. The stock price in the future has the same probability to increase as in that of going down. According to this theory it is impossible to outperform the market, unless additional risk is assumed. But some of the professionals argue that the stock market is at least somewhat predictable. Malkiel states that a long-term buy-and-hold strategy is better than technical, fundamental, or any other analysis. He supports his statement with the fact that most mutual funds that use random walk based analyses fail to beat benchmark averages.[156]

2.2.3 The Efficient Market Hypothesis

Not many studies about random walk theory appeared in the 1930's, but with a better understanding of the price formation in competitive markets, the random walk model became a center of debate for many scholars and was studied intensively in the 1960's. The random walk came to be seen as a set of observations that was compatible with the efficient markets hypothesis.

The efficient market hypothesis claims efficiency of financial markets and states that security prices accurately reflect all information concerning a stock or other security that is available at a given point in time and that prices rapidly adjust to any new information, including current and any future expectations, such as earnings or dividend payments as well. It aims to explain the random walk theory by taking assumption that only new information will result in significant change in stock prices. Because new information is presently unknown and occurs in random way, future movements in stock prices are also unknown and consequently move randomly. Therefore, an investor cannot outperform the market by picking undervalued stocks and earn abnormal returns by short-positioning, because the

[156] Jennifer Conrad, Book Review, "A Non-Random Walk down Wall Street by Andrew W. Lo, A. Craig Mackinlay," The Journal of Finance, Vol. 55, No. 1, 2000, pp. 515-518.

efficient market hypothesis states that there are no undervalued or even overvalued stocks.[157]

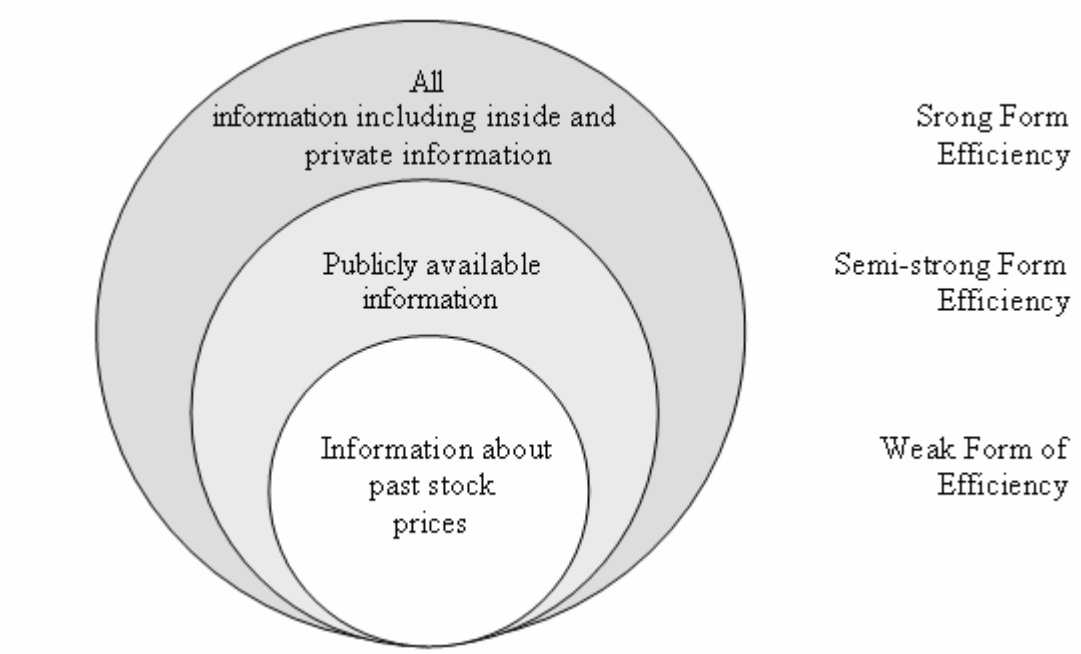
Based on Samuelson's microeconomic approach mentioned in the above paragraph and Harry Roberts'[158] classification of weak and strong form efficiency tests, in 1965, Eugene Fama published his dissertation arguing for the random walk hypothesis, and coined the concept of Efficient Market Hypothesis (EMH).[159] Later, in 1970, Fama assembled a comprehensive review of the theory and evidence of market efficiency.[160]

The theory involves defining an efficient market as one in which trading on available information fails to provide an abnormal profit. He made the argument that in an active market with well-informed and intelligent participants, assets will be appropriately priced and will reflect the effects of all available information based both on past and expected events. No information or analysis can be expected to result in outperformance of an appropriate benchmark if a market is efficient. As author states, "in an efficient market at any point in time the actual price of a security will be a good estimate of its intrinsic value."[161]

Fama classified the pricing efficiency of a market into three forms:[162] week, semi-strong, and strong as shown in Figure 19. The distinction between these forms lies in the notions of what it is meant by the term "all available information."

[157] Paul A. Samuelson, "Proof That Properly Anticipated Prices Fluctuate Randomly," Industrial Management Review, Vol. 6, No. 2, 1965, p.41.
[158] Harry Roberts, "Statistical Versus Clinical Prediction of the Stock Market," unpublished manuscript presented to the Seminar on the Analysis of Security Prices, University of Chicago, May 1967.
[159] Eugene Fama, "Random Walks In Stock Market Prices," Financial Analysts Journal, Vol. 21, No. 5, 1965 (Random Walks), pp.55-59.
[160] Eugene Fama, "Efficient Capital Markets: A Review of Theory and Empirical Work," Journal of Finance, Vol. 25, No. 2, 1970 (A Review of Theory), pp. 383-384.
[161] Fama, Random Walks, p. 56.
[162] Fama, A Review of Theory, p. 383.

Figure 19: Versions of the Efficient Market Hypothesis



2.2.3.1 Weak Form Efficiency

The weak form of the efficient market hypothesis claims that prices fully reflect the information implicit in the sequence of past prices, including the history of past prices, trading volume, or short interest. This form of efficiency implies that trend analysis that uses past prices alone would not be useful in finding undervalued stocks. The weak form efficiency holds that if such data ever conveyed reliable signal about future performance, all investors already would have learned to exploit signals. As the signals would be widely known, they would result in a rapid price increase.

2.2.3.2 Semi-strong Form Efficiency

The semi-strong form of the hypothesis asserts that prices reflect all relevant publicly available information regarding the prospects of a firm. Such as, in addition to past prices, fundamental data on the firm's product line, quality of management

and financial statements and news reports. Approaches that were predicated on using and massaging this information would not be useful in finding undervalued stocks.

2.2.3.3 Strong form efficiency

The strong form of market efficiency asserts information that is known to any participant is reflected in market prices, public as well as private, even information available only to company insiders and no investors will be able to consistently find undervalued stocks. But few would argue with this extreme proposition because corporate officers have access to pertinent information long before it is released to the general public.[163]

2.2.4 Market Efficiency in the Context of Asset Pricing

Efficient market is a perfect market and a market with elements of information asymmetry is imperfect and market efficiency is unattainable where there is information asymmetry.[164] A large body of evidence suggests that the capital markets are inefficient in certain aspects.[165] As was mentioned before, the hypothesis provides three basic definitions of market efficiency. While strong form market efficiency reflect all available information, the other two forms of market efficiency, semi-strong form and weak form efficiency do not reflect all available information and the market and uninformed participant can be outperformed by an informed one. The EMH is based on certain assumptions such as absence of transaction cost and that all investors are rational decision makers. The hypothesis assumes there is no information asymmetry in the three forms of market efficiency.[166] But there is information asymmetry caused by non-reflection of all available market information in the stock prices by the weak and semi-strong form markets. Information asymmetry in the stock market is caused with some investors possessing additional information about the firm, while others have only the publicly known

[163] Fabozzi and Modigliani, p.117.
[164] Shelley Thompson, Bruce Johnson, Dave Spearin and John Groenewegen, "Final Report - Market Signals in the Canadian Barley Sector: Draft Final Report," Western Canadian Wheat Growers Association, 15.11.2006, http://www.wbga.org/market-signals.pdf (03.14.2009), p.16.
[165] Kothari and Shanken, p. 5.
[166] Breeden, pp. 265-96.

information.[167] In informationally efficient market,[168] asset prices are assumed to reflect all relevant information in the market. If assets are traded based on the new information everybody possesses, it is certain that the asset price would reflect all the market information, containing insider information as well. Under such circumstances no trader can outperform each other or the market.[169]

One of the defects of traditional asset pricing models is the assumption that participants have homogeneous information. In real life, investors possess information heterogeneous in nature which means that investors possess different degrees of information. If market participants possess different levels of information it will result in information asymmetry and in such a situation the perception of the same product by market participants tend to be different.[170]

It was shown by various scholars that there is a direct relationship between degree of information asymmetry and the market prices. While information asymmetry decreases, the market prices increases. Not only do investors face problems caused by information asymmetry, but firms seeking external finance face the similar problems as well. As a consequence of asset mispricing, firms looking for funds from the capital market face the problem of information asymmetry.[171] Another argument which supports presence of information asymmetry was proposed by Beasley, Pagach and Warr. They argued that firms with higher growth potentials, which usually have embedded real options, face higher level of information asymmetry concerning future performances which may result in financial distress for the firm. As a result of information asymmetry, growth potentials are more likely to be underpriced during financial distress limiting the chance and creating higher costs

[167] Stephen Brown and Stephen A. Hillegeist, "Disclosure Quality and Information Asymmetry," Working Paper, University of Utah, 2003, p. 3.
[168] The notion of "informational financial market efficiency" should not be confused with the concept of the "mean–variance efficiency" of a portfolio.
[169] Felipe Zurita, "Essays on Speculation," A Dissertation Submitted In Partial Satisfaction of The Requirements For The Degree Doctor of Philosophy In Economics, University of California, Los Angeles, 1998, pp. 39.
[170] Robert Lensink and Elmer Sterken, "Capital Market Imperfections, Uncertainty and Corporate Investment in The Czech Republic," Economic Change and Restructuring, Springer, Vol. 33, 2000, pp. 53-54.
[171] Ronald W. Masulis and Rajarishi Nahata, "Strategic Investing and Financial Contracting in Start-Ups: Evidence from Corporate Venture Capital," ECGI - Finance Working Paper No 189/2007, 2007, p. 6-7.

to raise needed funds from the capital market to fund feasible growth opportunities.[172] The effect of information asymmetry on asset pricing may cause huge differences in price perception of an asset. To reduce the negative effect of this asymmetry, equity issuers usually engage with underwriters.[173]

Shortly, it can be concluded that information asymmetry has a significant impact on pricing of assets in the markets. For a market to allocate recourse properly, assets are needed to be properly priced, for this reason information asymmetry has to be reduced to a minimum.

2.3 STOCK MARKET ANOMALIES

A few decades ago, the efficient market hypothesis was widely accepted by academic financial economists. It has been tested by many researchers and, with few exceptions, found consistent with the data in a wide variety of markets, but by the start of the last century, the dominance of the efficient market hypothesis became far less universal. Many financial economists and statisticians, after their findings, started to believe that stock prices can be partially predicted[174] and a wide variety of apparent empirical relations between average stock returns and firm characteristics that are not explained by traditional asset pricing models were uncovered. [175]

The Capital Asset Pricing Model has been one of the cornerstones of modern finance since its development in the 1960s, but starting in the eighties with the discoveries of exceptions rather than verification of rules, the validity of the model started to be questioned. The empirical exceptions, referred either as investment strategies or anomalies, seriously have challenged the straightforward structures constructed by asset pricing models and characterized the path of empirical studies about equity markets for the past several years.

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[172] Mark Beasley, Don Pagach and Richard S. Warr, "The Information Conveyed In Hiring Announcements of Senior Executives Overseeing Enterprise-Wide Risk Management Process," Journal of Accounting, Auditing and Finance, 2007, Vol. 34, p. 211.

[173] Tim Loughran and Paul Schulz, "Asymmetric Information, Firm Location, and Equity Issuance," Working Paper, University of Notre Dame, 2006, pp.5-6.

[174] Burton G. Malkiel, "The Efficient Market Hypothesis and its Critics," Journal of Economic Perspective, Vol. 17, No. 1, 2003 (EMH and Critics), p. 63.

[175] Kothari and Shanken, pp. 7-9.

Kuhn is considered to be the first to mention the term anomaly in his studies. He says that inconsistencies that older cruder data and techniques missed in the past are beginning to be found as econometric sophistication increases and as better data becomes available.[176] Over the last three decades, anomalies have become increasingly important in asset allocation, estimates of the cost of capital, security analysis, hedge fund strategies, and many other applications. Understanding the exact sources of anomalies has been one of the most important questions in financial economics. Since the most prominent anomalies in the contemporary asset pricing literature are those that are related to firm size and the book to market value ratio,[177] tests in this thesis will be concentrated mainly on these anomalies.

Discoveries of anomalies in financial market typically come up from empirical tests that depend on joint null hypothesis which states security markets are informationally efficient and stock returns behave according to a prespecified equilibrium model. Documentation of anomalies often foreshadows a transitional stage toward a new paradigm. If the existing simple theoretical models are not successful in describing the actual pricing of risky assets within reasonable limits, they must be replaced by new, more accurate explanations of the data. The presence of anomalies means either market inefficiency which implies profit opportunities or inadequacies in the underlying asset pricing model.

Fundamentally, anomalies can only be defined relative to a model of normal return behavior. Thus, despite the fact that anomalies are often interpreted as evidence of market inefficiency, such a conclusion may turn out to be inappropriate because it may indicate that the underlying asset-pricing model is inadequate.[178] What is considered to be anomalous with respect to one asset pricing model may be consistent with the predictions of other models. For instance, an excess return associated with a stock's dividend yield has anomalous character in accordance with

[176] Michael C. Jensen, "Some Anomalous Evidence Regarding Market Efficient," Journal of Financial Economics, Vol. 6, Nos. 2/3, 1978, pp. 95-97..
[177] Ginger Wu and Lu Zhang, "Do Anomalies Exist Ex Ant?" University of Georgia Working Paper Series, October 4, 2008, p.2.
[178] G. William Schwert, "Anomalies and Market Efficiency," Ed. George M. Constantinides, Milton Harris and René M. Stulz, Handbook of the Economics of Finance, Elsevier., Ed. 1, Vol. 1, Chapter 15, 2003,. p. 959.

the basic Capital Asset Pricing Model but is consistent with extended versions that incorporate investor taxes.[179]

It has been argued that, after the documentation and analysis of anomalies in the academic literature, anomalies often seem to disappear, reverse, or wear out as investors try to profitably take advantage of the return patterns or because their discovery was simply an aberration caused by features specific to a sample. This kind of deduction leads on onto asking a question if profit opportunities existed in the past, but have since been arbitraged away in the course of time, or whether the anomalies were simply statistical aberrations that attracted academics' and practitioners' attention. Even though this was seen for some of the findings such as the weekend effect, most of discussed anomalies still continue to persist. The fact that so many of these patterns have existed for many years puts forward that idea that they are not evidence of market inefficiencies, but chosen benchmark models may describe equilibrium price formation less than completely. [180]

2.3.1 Calendar Anomalies

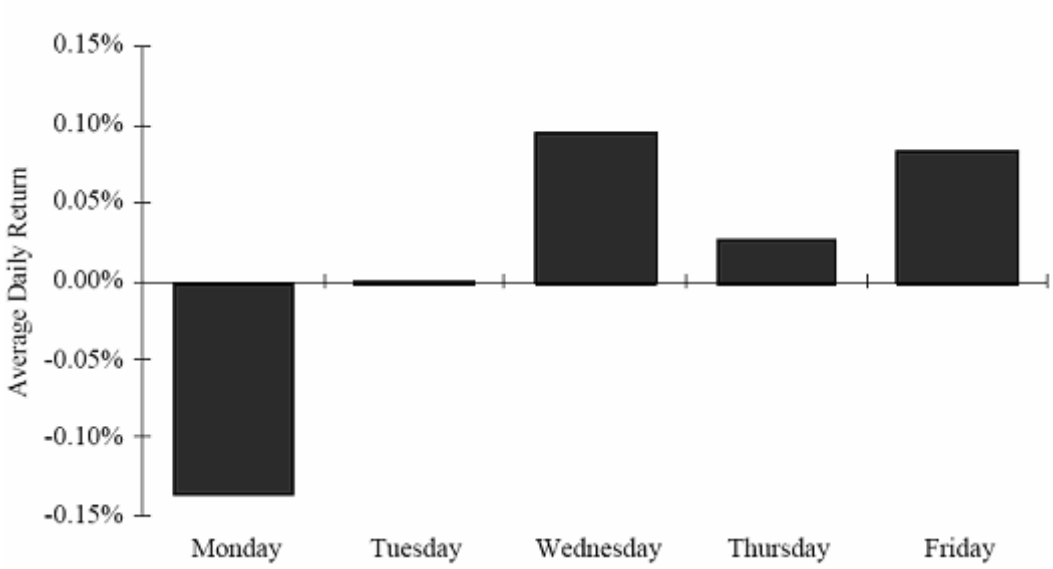
In accordance with traditional models of stock prices, expected stock returns were considered to be stable through time. However, recent research in finance has revealed that stock price behave inconsistent with the predictions of familiar models and suggests that expected stock returns are not constant, but contain a time-varying component that can be predicted by past returns, ex ante observable variables, and calendar turning points. These findings and evidences of seasonalities, raises a questions if Market Efficiency Theory is valid or not. The following sections discuss these evidences.

[179] Michael J. Brennan and Yihong Xia, "Assessing Asset Pricing Anomalies," Review of Financial Studies, Vol. 14, Issue 4, 2001, p. 905.
[180] Donald B. Keim, "Financial Market Anomalies," Ed. Steven N. Durlauf and Lawrence E. Blume, The New Palgrave Dictionary of Economics, Ed. 2, Palgrave Macmillan, London, 2008 (Financial Market Anomalies), p. 370.

2.3.1.1 The Day of the Week Effect

The day-of-the-week effect or relationship between returns and how they are related with the days of the week is a popular study area in finance literature. Cross[181] and French[182] report that average Monday return for the US market is negative and is less than the average return on the rest of the week.

Figure 20: Day of the Week Effect, S & P Composite, 1928 -1982



Source: Keim and Stambaugh, A Further Investigation of the Weekend Effect in Stock Returns, 1984.

Gibbons and Hess, contrary to the traditional distribution assumption that returns are identical for all days, also find that expected returns on common stock and treasury notes are not constant across the week. Returns on Monday were found to be negative.[183] An interesting result from these studies is that average returns on Monday are less than the other days of the week. The significance of the return

[181] Frank Cross, "The Behavior of Stock Prices on Fridays and Mondays," Financial Analyst Journal, Vol. 29, 1973, pp. 67-69.
[182] Kenneth French, "Stock Returns and the Weekend Effect," Journal of Financial Economics, Vol. 8, 1980, pp. 55-69.
[183] Michael R. Gibbons and Patrick Hess, "Day of the Week Effects and Asset Returns," Journal of Business, Vol. 54, 1981, pp. 579-596,

difference is brought out in Figure 20, which graphs returns by days of the week from 1962 to 1978 for the US market.[184]

The day of the week effect is not only an issue for the U.S. equity market, researches have found interesting results for equity, fixed income, derivative market for other countries as well.[185]

For the Turkish stock market there are also some papers that studied the-day-of-week effect. Demirer and Karan[186] reported that there was significant Friday effect but no clear evidence of a Monday effect in the Istanbul Stock Exchange for the period between 1988 and 1996. Contrary to the results reviewed by Aydoğan,[187] who stresses that there are no statistically significant differences among daily returns on ISE, Ercan Balaban documented some evidence in his paper that reports significant day of the week effects. For the period 1988-1994, the lowest and negative average return, although not significant, is observed on Tuesday. Friday is the only day for which average returns were all positive for individual periods. Balaban examines the relation between sign of Monday return and sign of previous Friday return. His results show that sign of Monday returns tend to follow sign of previous Friday returns.[188] Ozmen also showed that the highest returns between January 1988 and February 1992 were obtained on Fridays and the lowest on Thursdays.[189] Muradoğlu and Oktay analyzed the daily ISE returns within the period January 1988 to December 1992, although their study was unable to find a consistent day-of-the-week effect on stock returns, it found significantly negative Tuesday returns within the period 1990-1992 and positive Friday returns within the same period. They explain this weekend effect with the announcement of news about the

[184] Donald B. Keim and Robert F. Stambaugh, "A Further Investigation of the Weekend Effect in Stock Returns," Journal of Finance, Vol. 39, 1984, pp. 819-840
[185] Damodaran, Investment Valuation, p. 45.
[186] Rıza Demirer and Mehmet Baha Karan, "An Investigation of the Day of the Week Effect On Stock Returns in Turkey," Emerging Markets Finance and Trade, Vol. 6, No. 38, 2002, p. 47.
[187] Kürşat Aydoğan, "Hisse Senedi Fiyatlamasında Aykırılıklar," İşletme ve Finans Dergisi, Temmuz 1994, pp. 83-89.
[188] Ercan Balaban, "Day-of-the-Week Effects: New Evidence from an Emerging Stock Market," Applied Economics Letters, Vol. 2, 1995a, pp.139-143.
[189] Osman Barak, "Hisse Senedi Piyasalarında Anomaliler ve Bunları Açıklamak Üzere Gelistirilen Davranıssal Finans Modelleri IMKB'de Bir Uygulama," Doktora Tezi, Gazi Üniversitesi Sosyal Bilimler Enstitüsü, Ankara, 2006, s.131.

firms at the weekends[190] Aktaş and Kozoğlu concludes that it is possibe to gain profit by timing investment according to the patterns observed among the days of the week.[191]

2.3.1.2 The Holiday Effect

Earlier studies document that there is an abnormal return before holidays for a number of stock markets. Holiday effect was found by Ariel, Lakonishok and Smidt, who show that pre-holiday average returns are large and higher than post-holiday returns. Ariel shows that the average return of the day before holiday is eight times of that of other days and post-holiday return is usually negative.[192] Lakonishok and Smidt find exceptionally high returns for each of the two pre-holiday trading days preceding the Christmas and the New Year holidays. Variance of returns is also higher on the day following the holiday.[193] Other studies that explained this type of anomaly were presented by Kim and Park[194], and Mills and Coutts.[195]

The holiday effect in Istanbul Stock Exchange market prices was tested by various researches as well. Balaban and Candemir[196] provide results that show the presence of the states that average pre-holiday return is significantly higher than post-holiday return by approximately twofold to sevenfold depending on the period

[190] Gülnur Muradoğlu and Türkay Oktay, "Türk Hisse Senedi Piyasasynda Zayyf Etkinlik: Takvim Anomalileri," Hacettepe Universitesi Iktisadi ve idari Bilimler Fakultesi Dergisi, Cilt. 11, 1993, ss. 51-62.

[191] Hüseyin Aktaş and Metin Kozoğlu, "Haftanın Günleri Etkisinin İstanbul Menkul Kıymetler Borsası'nda GARCH Modeli ile Test Edilmesi," Finans Politik & Ekonomik Yorumlar, Vol. 44, No. 514, 2007, p. 37.

[192] Robert Ariel, "A Monthly Effect in Stock Returns," Journal of Financial Economics, Vol.18, 1987, pp. 161-174

[193] Josef Lakonishok and Seymour Smidt, "Are Seasonal Anomalies Real? A Ninety-Year Perspective," The Review of Financial Studies, Vol. 1, No. 4, 1988 (Seasonal Anomalies), pp. 403-425.

[194] Chan-Wung Kim and Jinwoo Park, "Holiday Effects and Stock Returns: Further Evidence," Journal of Financial and Quantitative Analysis, Vol. 29, 1994, pp. 145-157.

[195] Terence C. Mills and Andrew Coutts, "Calendar Effects in the London Stock Exchange FT-SE Indices," The European Journal of Finance, Vol. 1, 1995, pp. 79-93

[196] Baturalp Candemir and Ercan Balaban, "Istanbul Menkul Kiymetler Borsasinda Bahama Etkileri, Iktisat Isletme ve Finans, Vol. 10, 1995, pp. 93-104.

analyzed.[197] But contrary to them, in research done by Akyol, no evidence was found that would support the presence of the holiday effect.[198]

2.3.1.3 The Turn of the Month Effect

The turn of the month anomaly is observed when the last days of months and first couple of days of the following month are comparatively higher. The first to identify the anomalies in the U.S. stock prices at the beginning and end of the month was Ariel. He found that on the last day of the month and the three following days stock price changes are markedly positive.[199] Similar conclusion regarding the Italian stock market was made by Barone. Barone found that there was a clear difference between the first and second halves of the month. By excluding the observations corresponding to the first days of each monthly account to the trading days after a public holiday from the sample, it was found that stock prices fall in the first part of the month and then rise in the second. The price was particularly high at the end of the calendar month.[200] Lakonishok and Smidt also presented a study that shows that returns over days around the turn of the month are significantly higher than the average returns on the rest of trading days of the month.[201] Consistent to previous study on other countries, Bildik finds that returns in ISE are significantly higher than the rest of the month not only on the days at the beginning and end of the month, but in middle of the month as well.[202] Evidence presented by Akyol strengthened the existence of the turn-of-the-month effects in ISE. He also found that the returns on the last and first trading days of a month are statistically higher than the return on the rest of the month.[203]

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[197] Recep Bildik, "Are Calendar Anomalies Still Alive?: Evidence from Istanbul Stock Exchange," Harvard University - Kennedy School of Government Working Paper Series , May 27, 2004, p.14.
[198] Ali Akyol, "Calendar Anomalies in the Istanbul Stock Exchange," University of Melbourne Working Papers, May 2006, p.7.
[199] Richard Thaler, "Anomalies: Seasonal Movements in Security Prices II: Weekend, Holiday, Turn of the Month, and Intraday Effects," Economic Perspectives, Vol. 1, No. 1, 1987, p. 173.
[200] Emilio Barone, "Italian Stock Market," Journal of Banking and Finance, Vol. 19, 1988, pp.54-80.
[201] Lakonishok and Smidt, pp. 403-425.
[202] Bildik, p.13.
[203] Akyol, p.11.

2.3.1.4 The January Effect

January Effect is the most studied one among anomalies that bear characters of seasonality. According to January effect, the rate of return on stocks observed to be significantly higher during January. Rozeff and Kiney,[204] Lakonishok and Smidt[205] were the pioneers who originally documented the presence of January effect. This type of anomaly entitles that the rate of change in the stock prices in January is significantly higher that that of any other month. January effect is mostly interpreted using tax reduction hypothesis. According to which, investors, who tried to get a tax reduction, are the main cause of the January effect. Investors try to reduce the quantity from the tax by selling the stocks in December and make some loses. In January they buy stocks and make price increase, thus making some profit. However, there are some researches that explain these anomalies by window-dressing hypothesis, which suggests that window-dressing at year-end by investors, particularly institutional investors, results in high January returns for risky securities. These investors sell securities that are considered to be losers and window-dress their end-of-year balance sheets. Following the turn-of-the-year, they repurchase speculative securities. [206]

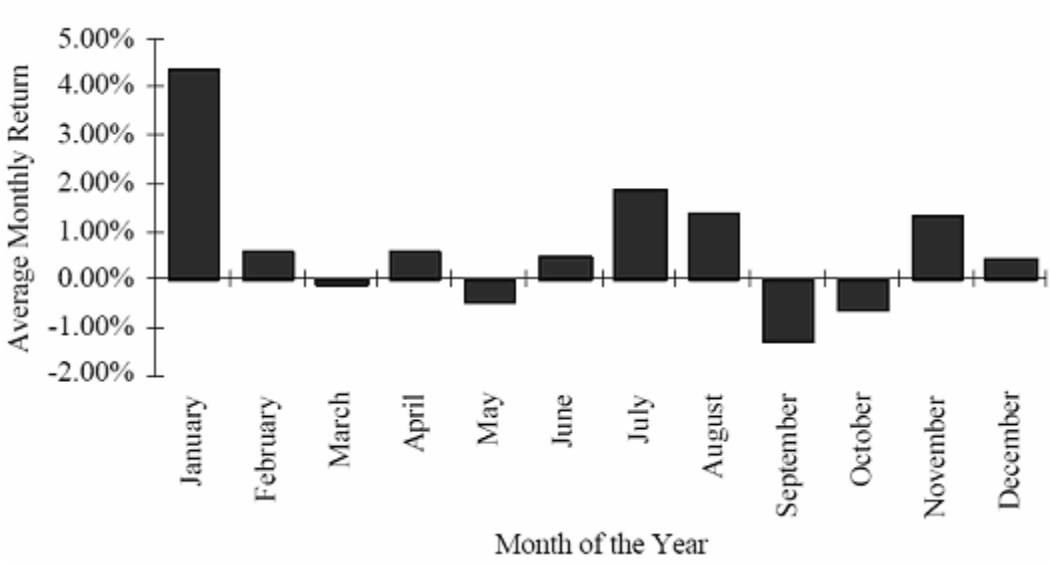
Studies of returns in the United States reveal strong differences in return behavior across the months of the year. Figure 21 reports average returns by month of the year from 1926 to 1983 for the U.S. market.[207]

Keim showed that January effect persists due largely to price behavior in the first five trading days of January. [208] Another study worth mentioning is the research

[204] Michael S. Rozeff and William R. Kinney, "Capital Market Seasonality: the Case of Stock Returns," Journal of Financial Economics, Vol. 3, 1976, pp. 379-402.
[205] Lakonishok and Smidt, pp. 407-409.
[206] Rohan Christie-David and Mukesh Chaudhry, "January Anomalies-Implications for the Market's Incorporation of News," The Financial Review, Vol. 35, 2000, p. 79-80.
[207] Damodaran, Investment Valuation, p. 41.
[208] Donald B. Keim, "Size-related Anomalies and Stock Return Seasonality: Further Empirical Evidence," Journal of Financial Economics, Vol. 12, No.1, 1983 (Size-related Anomalies), pp.13-32.

conducted by Reinganum. He found that January effect appears to primarily exist for small firms.[209]

Figure 21: Average Returns by Month of the Year



Source: Damodaran, Investment Valuation, 2002.

Murat Çinko, tested January effect for ISE for the period starting from January 1989 and December 2006, and found no evidence to prove the January effect in Istanbul Stock Exchange,[210] but contrary to them, Karan and Uygur reached a conclusion that there is January effect in Istanbul Stock Exchange.[211] While research conducted by Durukan and Evrim support the presence of January effect,[212] Akyol shows that January effect has disappeared in last couple of years.[213]

[209] Marc R. Reinganum, "The Anomalous Stock Market Behavior of Small Firms in January: Empirical Tests for Tax-Loss Selling Effects," Journal of Financial Economics, Vol. 2, No. 1, 1983 (Stock Market Behavior), pp.89-90.
[210] Murat Çinko, "İstanbul Menkul Kıymetler Borsasında Ocak Ayı Etkisi" Doğuş Üniversitesi Dergisi, Cilt. 9, Sayı. 1, 2008, s. 47.
[211] Mehmet Baha Karan and A. Uygur, "Neglected Stock Effect in Istanbul Stock Exchange," Hacettepe University Faculty Journal of Economic and Administrative Sciences, Vol. 18, No. 1, 2000, p. 129.
[212] Banu Durukan and Pınar Evrim, "The Relationship between Stock Returns and Fundamental Variables: Evidence from Istanbul Stock Exchange," Dokuz Eylul Univeristy, Journal of Faculty of Business, Vol. 4 No. 1, 2003, p.76.
[213] Akyol, p.2-3

2.3.2 Value-Size Anomalies

The CAPM under certain simplifying assumptions, states that the return on an asset is linearly related to the security's beta, measured relative to the market portfolio of all marketable securities. Security returns will on average conform to this linear relation if the model is correct and security markets are efficient. Thanks to the creation of computerized databases of stock prices, it became possible to empirically test the CAPM. To implement the tests, researchers often estimate cross-sectional regressions of the form:

$$R_i = \alpha_o + \alpha_1 \beta_i + \sum \alpha_j c_{ij} + \varepsilon_i \tag{26}$$

where β_i is the beta of the security that measures its covariance with the return on the market and c_{ij} represents security-specific characteristic j such as size, earnings yields and etc. for security i. The CAPM predicts that for $j > 1$, the α_i are zero. Early tests found significant positive values for α_1 and insignificant values for α_i, for $j > 1$, which supported the CAPM. But in the late 1970s, researchers identified security characteristics such as the earnings-to-price ratio (E/P), size and dividend yield with more explanatory power than beta.[214] Consequently the explanatory power of beta became a subject of discussions among researchers.

In this section cross-sectional return predictability that stand as a challenge for alternative asset pricing models and their presence in Istanbul Stock Exchange will be presented.

2.3.2.1 The Value Effect

The value effect occurs when there is a positive relation between security returns and the ratio of accounting-based measures of cash flow or value to the market price of the security. Earnings-to-Price ratio (E/P), Market-to-Book ratio

[214] Keim, Financial Market Anomalies, pp. 371–372.

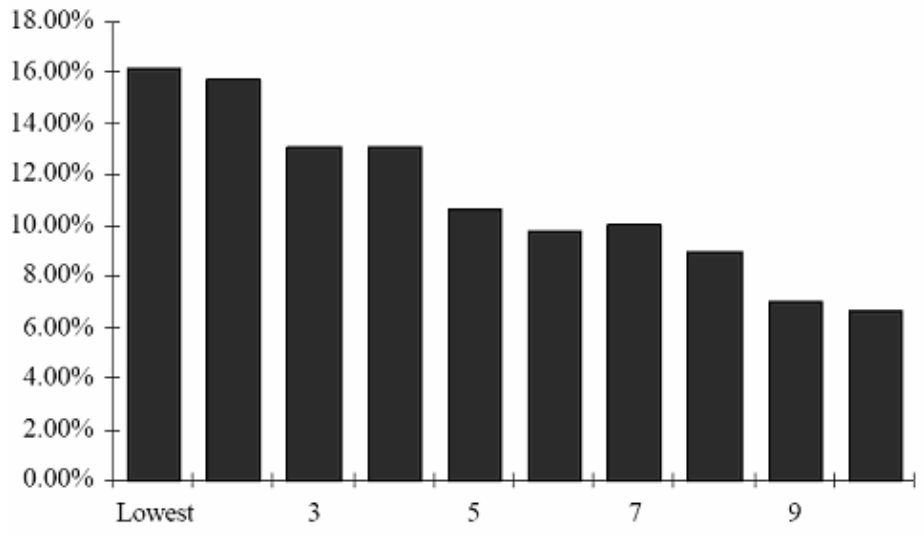
(MV/BV) and dividend yield are examples of the accounting-based measures. Investment strategies based on the value effect can be traced at least to Graham and Dodd.[215] The first who tested the hypothesis that value-related variables can explain violations of the CAPM was Basu.[216] Thus, if the CAPM is an incomplete specification of priced risk, it is reasonable to expect that accounting-based ratios might explain the portion of expected return that is compensation for risk variables omitted from the tests.

2.3.2.1.1 Price Earnings Ratio

Investors have long argued that stocks with low price earnings ratios are more likely to be undervalued and earn excess returns. This type of anomaly involves long (short) positions in high (low) earnings-to-price ratio stocks.[217] For instance, Graham uses low price earnings ratios as a screen for finding undervalued stocks. Studies that have looked at the relationship between P/E or E/P ratios and excess returns confirm these priors.[218] As was mentioned in the preceding paragraph Basu found that P/E variables can explain violations of the CAPM. Reinganum also confirmed and extended Basu's findings.[219] Figure 22 summarizes annual returns by P/E ratio classes for stocks in the U.S. market from 1967 to 1988.[220]

[215] Benjamin Graham and David Le Fevre Dodd, Security Analysis: The Classic 1951 Edition, Ed.3, McGraw-Hill, New York, 2005, pp.636-641.
[216] Sanjay Basu, "Investment Performance of Common Stocks in Relation to their Price-Earnings Ratio: A Test of the Efficient Market Hypothesis," Journal of Finance, Vol. 32, 1977, pp. 663-682.
[217] Victor Bernard, Jacob K. Thomas, and James Michael Wahlen, "Accounting-Based Stock Price Anomalies: Separating Market Inefficiencies from Risk," Contemporary Accounting Research, Vol. 14, No. 2, Summer 1997, p.87
[218] Benjamin Graham, The Intelligent Investor: A Book of Practical Counsel, Updated with New Commentary by Jason Zweig, Harper Business Essentials, New York, 2003, p.310.
[219] Marc R. Reinganum, "A Misspecification of Capital Asset Pricing: Empirical Anomalies Based on Earnings Yields and Market Values," Journal of Financial Economics, Vol. 9, 1981 (Misspecification of CAPM), pp. 19-46.
[220] Damodaran, Investment Valuation, p. 38.

Figure 22: Annual Return by P/E ratio Class



Source: Damodaran, Investment Valuation, 2002.

While, as it is shown in the figure above, firms in the highest P/E ratio class earned an average return of only 6.64%, firms in the lowest P/E ratio class earned an average return of 16.26%. The exceed returns earned by low P/E ratio stocks is not inherent not only to the U.S., return predictability based on this accounting based ratio is also observed in other international markets. Evidence found in other financial markets outside the U.S. are summarized in Table 1, where annual premium is the premium earned over an index of equally weighted stock in that market between January 1, 1989 and December 31, 1994. [221]

Table 1: Excess Returns on Low P/E Ratio Stocks by Country, 1989-1994

Country	*Annual Premium earned by lowest P/E Stocks (bottom quintile)*
Australia	3.03%
France	6.40%
Germany	1.06%
Hong Kong	6.60%
Italy	14.16%
Japan	7.30%
Switzerland	9.02%
U.K.	2.40%

Source: Damodaran, Investment Valuation, 2002.

[221] Damodaran, Investment Valuation, p. 39.

The presence of return predictability based on earnings-to-price (or price-to earnings) ratio has been tested by several scholars for the Istanbul Stock Exchange stock prices.

Karan reports that portfolios with low P/E overperform ones with high P/E ratios during the period of 1988-1993.[222] Karan in his later study on ISE analyzes the effect of P/E ratio on stock returns for the period from 1989 to1995. His findings provide evidence that the P/E ratio is statistically important in explaining stock returns. It was also found that the portfolios with low P/E ratio have also low Price /Sales (P/S) and MV/BV ratios at the same time.[223]

Demir and et al. in their study on ISE, for the 1990-1996 period, analyze the effect of the P/E ratio, firm size, and earnings factors. They document that the average returns to low P/E portfolios are greater than those of high P/E portfolios during the period 1990-1996, but they argue the difference disappears when risk-adjusted returns are used. They also analyze the month effect for portfolios formed based on firm size and suggest that the strongest relationship exist in June. [224]

Canbaş, Kandır and Erişmiş in their study investigate the effects of firm characteristics on stock returns for the sample period from July 1992 to June 2005, where nonfinancial ISE firms were included. On the contrary with the existing literature, they found that the portfolio with the lowest earnings-to-price ratio seem to have earned the highest rate of return.[225]

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[222] Mehmet Baha Karan, "Hisse Senetlerine Yapılan Yatırımların Performanslarının Fiyat/Kazanç Oranına Göre Değerlendirilmesi: IMKB Üzerine Ampirik bir Çalışma," İşletme ve Finans, Vol. 11, 1995, pp. 26-35 (Fiyat/Kazanç).

[223] Mehmet Baha. Karan, "IMKB'de Fiyat/Satış ve Pazar Değeri/Defter Değeri Oranı Etkileri: Karşılaştırmalı bir Çalışma," İşletme ve Finans, November, 1996 (Pazar Değeri/Defter Değeri Oranı), pp. 73-91.

[224] Ahmet Demir et al., "An Analysis of Portfolio Returns Formed on the Basis of E/P and Frm Sze," İşletme ve Finans, November 1996, pp. 41-69.

[225] Serpil Canbaş, Serkan Yılmaz Kandır and Ahmet Erişmiş, "Testing Firm Characteristics That Affect Stock Returns for ISE Companies (in Turkish)," Finans Politik & Ekonomik Yorumlar, Vol 44, No. 512, 2007, p. 15.

2.3.2.1.2 Price Book Value Ratio

Another accounting based measure that is widely used by investors in investment strategy is price book value ratios. It has been considered that a low price book value ratio is a reliable indicator of undervaluation of firms. Most of the scholars who tested the value effect studied investment strategies concerning the price earnings ratio together with the relationship between returns and price book value ratios. It was found by some researchers that there is a negative relationship between returns and price book value ratios. Stocks with low price book value ratio earn higher returns compared to those which have high price book value ratio. This value strategy invests long in value stocks (that are undervalued relative to book value) with high ratios of book value-to-market value of equity, and sells short growth stocks (that are overvalued relative to book value) with low ratios of book value-to-market value of equity.[226]

It was found by Rosenberg, Reid and Lanstein that the average returns on U.S. stocks are positively related to the ratio of a firm's book value to market value. In their study for the period between 1973 and 1984, they show the strategy of picking stocks with low price-book values yielded an excess return of 36 basis points a month.[227]

Fama and French examined the cross-section of expected stock returns between 1963 and 1990. They establish that there is a positive relationship between book-to-price ratios and average returns in the univariate and multivariate tests as well. They even found that this type value effect is stronger than of the size effect in explaining returns. They classified firms on the basis of book-to-price ratios into twelve portfolios, firms in the lowest price-to-book class earned an average monthly return six times more than the firms in the lowest book-to-price[228] Findings presented by Barber and Lyon supplement Fama and French with supporting empirical evidence for stocks in the financial sector. Their test which covers the period from

[226] Bernard, Thomas and Wahlen, p. 87.
[227] Barr Rosenberg, Kenneth Reid, and Ronald Lanstein, "Persuasive Evidence of Market Inefficiency," Journal of Portfolio Management, Vol. 11, No. 3, 1985, pp. 9-17.
[228] Fama and French, The Cross-Section, pp. 427–465.

1940 to 1962 reveals a strong relationship between book-to-market and stock returns.[229]

The evidence of positive relationship between book-to-price ratios and average returns is not restricted with the U.S. stock market. Chan, Hamao and Lakonishok find that in explaining the cross-section of average returns on Japanese stocks, the book-to-market ratio has a strong role.[230] Elfkhani, Lockwood and Zaher examine the size and BV/MV effect in the Canadian stock market. They also find that there is a significant relationship between the book-to-market ratio and returns. However, the results are not significant outside of January in all sub periods.[231]

Aksu and Önder also found that book-to-market ratio has effect in the ISE for the 1993-1997 period on price of stocks traded on Istanbul Stock Exchange. They show that stocks with high book-to-market ratios provide significant excess returns.[232] On contrary to their result, the study Durukan and Evrim, which cover a time period from 1990 to 2000, suggests that market-to-book ratio (MV/BV) do no have explanatory power on return.[233]

Capaul, Rowley and Sharpe analyzed market-to-book value ratios in other international markets for sample of stocks between 1981 and 1992, and concluded that in every market that they analyzed stocks with low market-to-book value ratios earned excess returns. Annualized estimates of the return differential earned by low market-to-book value stocks, over the market index, were as shown in Table 2:[234]

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[229] Brad M. Barber and John D. Lyon, "Detecting Long-run Abnormal Stock Returns: The Empirical Power and Specification of Test Statistics," Journal of Financial Economics, Vol. 43, 1997, pp. 341-372.

[230] Louis K. Chan, Yasushi Hamao and Joseph Lakonishok, "Fundamentals and Stock Returns in Japan," Journal of Finance, Vol. 46, 1991, pp. 1739-1764.

[231] Said Elfkahni, Lamy J. Lockwood and Tarek S. Zaher, "Small Firm and Value Effects in the Canadian Stock Market," Journal of Financial Research, Vol. 31, 1998, pp. 277-291

[232] Mine H. Aksu and Türkan Önder, "The Size and Book-to-Market Effects and Their Role as Risk Proxies in the Istanbul Stock Exchange," European Financial Management, 2000 Annual Meeting, Norfolk, VA : EFMA, January 2003, pp.1-46.

[233] Durukan and Evrim, p.76.

[234] Carlo Capaul, Ian Rowley, and William F. Sharpe, "International Value and Growth Stock Returns," Financial Analysts Journal, Vol. 49, 1993, pp .27-36.

Table 2: Return Differential Earned by Stocks with Low MV/BV ratios

Country	Added Return to low M/B portfolio
France	3.26%
Germany	1.39%
Switzerland	1.17%
U.K.	1.09%
Japan	3.43%
U.S.	1.06%
Europe	1.30%
Global	1.88%

Source: Capaul, Rowley, and Sharpe, International Value and Growth Stock Returns, 1993.

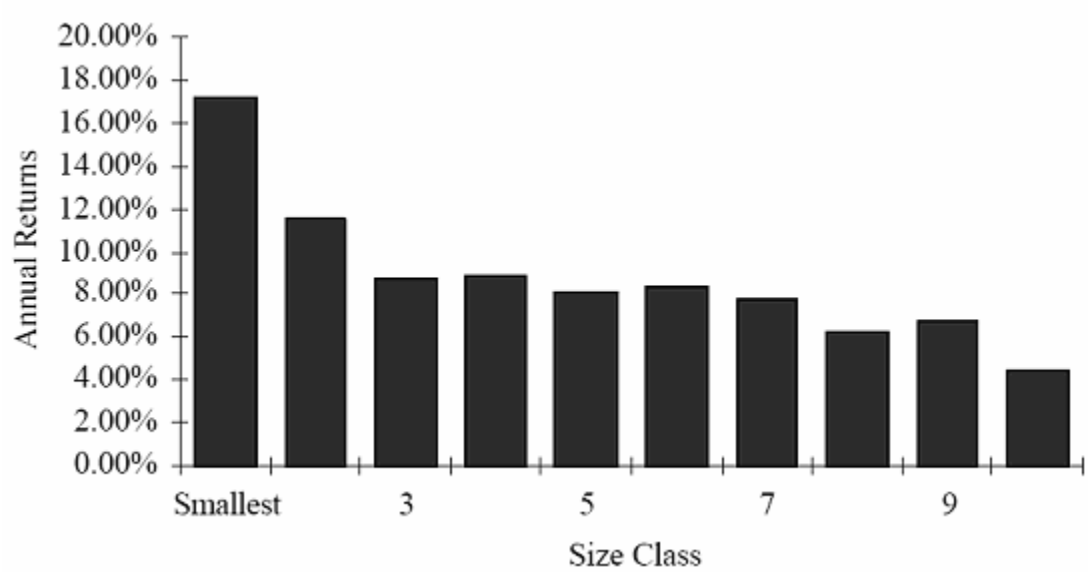
2.3.2.2 The Size Effect

The size effect occurs when there is a negative relation between security returns and the market value of the common equity of a firm. It is one of the oldest and widely studied anomalies in the finance literature. Significant amount of studies have found that firms with smaller market value of equity earn higher returns than larger firms of equivalent risk, β. The first to document this phenomenon for U.S. stocks was Banz.[235] He found that in a sample of common stocks listed on New York Stock Exchange (NYSE) between 1926 and 1975, the coefficient on size has more explanatory power than the coefficient on beta in describing the cross section of returns. In addition, he finds that market value is an excellent predictor of expected return, even better than the CAPM itself. The article shows that it is possible to earn abnormal arbitrage returns by entering into short position in large or medium capitalization stocks and investing the proceeds in a portfolio of small capitalization stocks. [236] Reinganum also suggested a serious misspecification in the CAPM. He established that another effect, the predictive power of the E/P, was in fact related to the size anomaly. Reinganum showed that when size is controlled for the E/P,

[235] Rolf Banz, "The Relationship between Return and Market Value of Common Stock," Journal of Financial Economics, Vol. 9, 1981, pp. 3-18.
[236] Quang-Ngoc Nguyen, Thomas A, Fetherston and Jonathan A. Batten, "Size and Book-to-Market Effects in the Returns on Information Technology Stock," Ed. Andrew H. Chen, Research in Finance, Vol. 21, Emerald Group Publishing Limited, 2004, pp. 45.

anomaly disappears.[237] Damodaran reports that, with some variation across time, the small firm return has been generally positive. It was highest during the 1970s and lowest during the 1980s in U.S. (Figure 23).[238]

Figure 23: Annual Returns by Size Class, 1927 – 1983, U.S.



Source: Damodaran, Investment Valuation, 2002.

Fama and French also demonstrated a negative relationship between stock return and firm size for the time period between 1942 and 1990.[239] However, Knez and Ready argue that the premium on size estimated by Fama and French completely disappears when 1% of the most extreme observations on size are trimmed.[240]

Some researches as Barry and Brown,[241] Brown et al.[242] found results similar consistent to those of Banz and Reinganum for both the US and non-US markets. However, Dimson and Marsh, after examining the UK stock market, found that

[237] Reinganum, Misspecification of CAPM, pp. 19-46.
[238] Damodaran, Investment Valuation, p. 36.
[239] Fama and French, The Cross-Section, pp.427-466.
[240] Peter J. Knez and Mark J. Ready, "On the Robustness of Size and Book-to-Market in Cross-Sectional Regressions," Journal of Finance, Vol. 52, 1997, pp. 1355-1358.
[241] Christopher B. Barry and Stephen J. Brown, "Differential Information and the Small Firm Effect," Journal of Financial Economics, Vol. 13, No. 2, 1984, pp. 283-285.
[242] Philip Brown, Allan W. Kleidon and Tarry A. Marsh, "New Evidence on the Nature of Size Related Anomalies in Stock Prices," Journal of Financial Economics, Vol. 12, 1983, pp. 33-56.

although smaller firms generally outperformed larger firms between 1955 and 1988, this pattern was reversed during the following decade.[243, 244] Horowitz et al., using the annual compounded returns for the 1980-1996 period, found no systematic relationship between realized returns and firm size in the U.S. These findings are contrary to the findings of Banz and Reinganum, and are called as the reversing or disappearing size effect.[245]

So far researchers naturally tried to discredit the conclusions of the studies by looking for faults in the data or taken methodologies. The integrity of the CAPM could have been maintained if serious defects in the size effect research could have been found. A number of supposition were offered as potential problems, but none of these could adequately explain the magnitude of the misspecification initially reported by Banz and Reinganum[246]

Civelekoglu tested the presence of size effect for the period between 1990 and 1992 for the stocks listed in ISE. It was observed that during the period of 1991-1992 portfolios of big stocks earned higher return than that of small stocks.[247] Consistent with the researches that support size anomaly, Topsever shows that for the 1988-1997 period portfolios of small stocks outperform both portfolios with big stocks and the whole market in terms of earnings.[248] Bastürk also concluded that there was a size anomaly in ISE stock prices for the1995–2000 period.[249] Similar result was presented by Pınar, whose sample covered the time interval between 1990

[243] Elroy Dimson and Paul R. Marsh, "Event Study Methodologies and the Size Effect," Journal of Financial Economics, Vol. 17, No. 1, 1986, pp.113-142.
[244] Joel L. Horowitz, Tim Loughran and Eugene Savin,, "Three Analyses of Size Premium," Journal of Empirical Finance, Vol. 7, No. 2, 2000, pp. 143–153.
[245] Tung Liang Liao, "Size Anomaly on the Taiwan Stock Exchange- An Alternative Test," Journal of Emerging Market Finance, Vol. 4, No. 1, 2005, pp. 81-100.
[246] Reinganum, Anomalies, p. 438.
[247] Civelekoglu Hakan, "An Investigation of Anomalies at IMKB: Size and E/P Effects," Master's Thesis, Bilkent University, 1993.
[248] Vedat Topsever, "IMKB'de Gözlemlenen Anomalilere Kısa Bir Bakıs ve Firma Büyüklügü Etkisi Üzerine Bir Deneme," Yüksek Lisans Tezi, Marmara Üniversitesi Bankacılık ve Sigortacılık Enstitüsü, 1998.
[249] Feride Bastürk, "F/K Oranı ve Firma Büyüklügü Anomalilerinin Bir Arada Ele Alınarak Portföy Olusturulması ve Bir Uygulama Örnegi," Doktora Tezi, Eskisehir Anadolu Üniversitesi Sosyal Bilimler Enstitüsü, Eskisehir, 2002.

and 2000.[250] Karan also supported previous researches by establishing significant effect of size on stock prices.[251]

2.3.3 Explanation of Anomalies

The violations of the CAPM found in empirical studies have inspired financial academics to find plausible explanations for anomalous patters of stock returns. In this section these explanations will be classified into three main categories: rational, tax-based and behavioral explanations.

2.3.3.1 Rational Explanation

The followers of rational explanation generally focus on the possible errors in the tests of the models. They assume that the efficient market hypothesis holds, and that stock returns cannot be predicted. They question why these regularities are found and what their causes are.

2.3.3.1.1 Data Mining Biases

Data mining is the process of searching through historical data to find significant patterns, with which researchers can build a model and make conclusions and predictions on how this population may behave in the future. So far many analysts have been concerned that the process of examining significantly influences the likelihood of finding anomalies. When analysts rely too heavily on data-mining practices and repeatedly use the same database to search for patterns or trading, some errors might occur. Since stock return anomalies have predictable patterns, one who studies hundreds of different relationships and thousands of different observations is likely to find a pattern. That is, while some patterns discovered in data mining are potentially useful, many others might just be result of coincidence and are not likely to be repeated in the future. In of his articles, F. Black said that "most of the so-

[250] Talip Pınar, "Hisse Senedi Getirilerinde Firma Büyüklügü Etkisi: IMKB'de Uygulamalı Bir Analiz," Yüksek Lisans Tezi, Gebze Yüksek Teknoloji Enstitüsü , Gebze, 2002.
[251] Mehmet B. Karan, "The Anomalies of the Istanbul Stock Exchange," Ege Ekonomik Bakış Dergisi, Vol.1, No. 2, 2003, p. 36.

called anomalies that have plagued the literature on investments seem likely the results of data-mining".[252] Lo and MacKinlay[253] also illustrate the data-mining phenomenon and show how the conclusions drawn from such exercises can be misleading.

To resolve this problem some researchers advise to test the anomaly on an independent sample: data from other countries or data from prior time periods can be used for these purposes.[254]

2.3.3.1.2 Survivorship Bias

Whenever results are based on existing entities, there is a chance of survivorship bias. The main argument of proponents of survivorship bias hypothesis state that there is a tendency for financial and accounting databases to include only stocks that have survived the historical period, while other, poor performing stocks or mutual funds that at one time existed are eliminated from the current dataset. As a result, observed investment returns are too high and existing mutual funds on average outperform their benchmark, because only well-performing funds continue to survive, while underperformers die. If all funds, on average, dead and alive, are included in the sample, then, the funds on average may not outperform their benchmarks.

The prime proponents of a survivorship bias story, Kothari, Shanken, and Sloan argue that average returns of companies with high-book-to-market ratios are overstated because dataset is more likely to include distressed firms that survive and to miss distressed firms that fail.[255] Contrary to aforementioned hypothesis, Chan,

[252] Black, p.3.
[253] Andrew W. Lo and A. Craig MacKinlay, "Data-Snooping Biases in Tests of Financial Asset Pricing Models," Review of Financial Studies, Vol. 3, No. 3. 1990, pp. 431-467.
[254] Schwert, p. 943.
[255] S.P. Kothari, Jay Shanken, and Richard G. Sloan, "Another Look at the Cross-Section of Expected Returns," Journal of Finance, Vol. 50, 1995, pp. 185-224.

Jegadeesh, and Lakonishok claim that survivorship bias is small and cannot explain the strong relation between average return and book-to-market ratios. [256]

2.3.3.1.3 Selection Bias

In the case of stock market studies, selection bias may take place when the results come from a certain portion of the sample but seem to represent the entire market. It is important to identify selection bias before applying the results to entire sample. As it is known January effects state that firms returns follow abnormal pattern in the first few days of January, but the effect is caused by small firms and cannot be attributed to the whole stock market. When small firms are omitted from the sample, the January effect disappears. [257] Even though selection biases can not explain all of the book-to-market effect, it is important to assess what fraction of the anomalies is caused by the biases.[258]

2.3.3.1.4 Distress Risk

To explain anomalous patterns in the cross-section of stock returns some scholars have introduced concept of financial distress. The main idea of this concept is that certain companies have an overstated probability that they will fail to meet their financial obligations. The stock prices of these financially distressed companies tend to move together, which makes their risk undiversifiable. Naturally, investors charge a premium for bearing such risk.

Fama and French point out that low price-book value ratio can be used as a measure of risk, because firms with prices well below book value are more likely to be in trouble and go bankrupt. Therefore before investing in these firms, investors must take into consideration whether the additional returns made by such firms

[256] Louis K.C. Chan, , Narasimhan Jegadeesh, and Josef Lakonishok, "Evaluating the Performance of Value versus Glamour Stocks: The Impact of Selection Bias," Journal of Financial Economics, Vol. 38, 1995, pp. 269-296.
[257] Vijay Singal, Beyond the Random Walk: A Guide To Stock Market Anomalies And Low-risk Investing, Oxford University Press, New York, 2006, p.12.
[258] William J. Breen and Robert A. Korajczyk, "On Selection Biases in Book-to-Market Based Tests of Asset Pricing Models," Northwestern University Working Paper, No. 167, 1995, p. 6.

justifies the additional risk.[259] Chan and Chen also state that a portfolio of value stocks have higher returns because it is likely to incorporate distressed firms, with high financial leverage, and with substantial earnings uncertainty in the future[260] However, by showing that bankruptcy risk is not related to future returns, Dichev refutes the financial distress explanation for the B/M effect. [261]

Standard CAPM may not capture the premium for distress risk if corporate failures are correlated with declines in unmeasured components of wealth such as human capital or debt securities or worsening investment opportunities. If that is the case distress risk may be useful in explaining the size and value effects that are considered to be anomalies in the standard CAPM. [262]

2.3.3.1.5 Skewed Distributions

Another explanation of anomalies is based on the asymmetries found in return distributions. It relates Fama and French factors with the skewness and kurtosis found in return distribution of stock. Statistical tests of significance usually rely on the standard assumption of normal distributed variables. In fact, empirical results show that in many cases variables such as abnormal returns are not normal distributed but skewed.[263]

Knez and Ready show that that the Fama and French studies were very influenced by outliers in the data. They found that size effect is explained by only a few small firms with extreme returns. The skewness of small-firm returns is higher and they explain this phenomenon by the turtle eggs hypothesis, which states that "while a few small firms burst forward each month, most seem to languish". [264]

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[259] Fama and French, Multifactor Explanation, pp. 56-67.
[260] K.C. Chan and Nai-fu Chen, "Structural and Return Characteristics of Small and Large Firms," Journal of Finance, Vol. 46, 1991, pp. 1467-1484.
[261] Ilia D. Dichev, "Is Risk of Bankruptcy a Systematic Risk?" Journal of Finance, Vol. 53, 1998, pp. 1131-1147.
[262] John Y. Campbell, Jens Hilscher, and Jan Szilagyi, "In Search of Distress Risk," Journal of Finance, American Finance Association, Vol. 63, No. 6, 2008, p. 2899.
[263] John D. Lyon, Brad M. Barber and Chih-ling Tsai, "Improved Methods for Tests of Long-run Abnormal Stock Returns," The Journal of Finance, Vol. 54, No. 1, 1999, pp. 165-166.
[264] Knez and Ready, p. 1376.

Harvey and Siddique suggest that the momentum effect – recent past winners outperform recent past losers – is related to systematic skewness. The low expected return momentum portfolios have higher skewness than high expected return portfolios.[265] Another study that supports this explanation was presented by Smit and Vliet. They state that there is an asymmetry in return distribution over the cross section of firms and it is mainly caused by the existence growth opportunities held by some firms.[266]

2.3.3.2 Tax-based Explanation

In the light of empirical findings, some researchers tried to explain January and size effect by tax-loss hypothesis. It "denies that securities are perfect substitutes and, rather, asserts that taxation-induced transaction causes a movement along a downward sloping demand schedule. Thus, it directly contradicts the wieldy accepted proposition that the capital markets are efficient."[267]

Tax-loss selling has undesirable effect on stock price movements because it offers an incentive for investors to realize capital losses and to defer capital gains. Since small stocks typically have higher variances of price changes and, consequently, larger probabilities of large price declines, it is likely that small firms stocks are chosen in tax-loss selling. Investors sell securities in which they have losses in order to take advantage of accrued capital losses shortly before year-end. This selling pressure would depress prices at year-end and the prices would then rebound in January.[268]

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[265] Campbell R. Harvey and Akhtar Siddique, "Conditional Skewness in Asset Pricing Tests," Journal of Finance, Vol. 55, 2000, p.1263.
[266] Han Smit and Pim Vliet, "Real Options and Stock Market Anomalies," Paper presented in the Sixth Annual Real Options Conference, July 2002, p. 1.
[267] Edward Dyl, "Capital Gains Taxation and the Year-End Stock Market Behavior," Journal of Finance, Vol. 32, 1977, pp. 165.
[268] Philip Brown et al, "Stock return seasonalities and the tax-loss selling hypothesis : Analysis of the arguments and Australian evidence," Journal of Financial Economics, 1983, Vol. 12, No. 1, 1983, p. 107.

2.3.3.3 Behavioral Explanation

At the end of last century, the focus of many academic discussions shifted away from econometric analyses of time series on prices, dividends and earnings toward psychology based models in explaining financial markets behavior. Many studies that have found long-term historical phenomena in securities markets that were contrary to the efficient market hypothesis and were unable to be described by the models based on perfect investor rationality. Some researchers proposed behavioral finance as the new field in finance to explain these phenomena.[269] It aims to explain empirical anomalies by introducing investor psychology as a determinant of asset pricing. The main assumption is that the information structure and the characteristics of market participants systematically influence investment decisions of both individuals and that of market.

Behavioral explanation is mostly used in explaining anomalies such as underreaction and overreaction. Underreaction defines a slow adjustment of prices to announcements or corporate events, whereas overreaction deals with extreme stock price reactions to previous information or past performance. [270] De Bondt and Thaler argued that investors overreact to both bad news and good news. As a result, overreaction leads to past losers being underpriced and to past winners being overpriced.[271] According to Lakonishok, Schleifer, and Vishny, in consistence with DeBondt and Thaler, investors rely too much on past performance in determining future performance: value stocks, stocks that with poor performance in the past, are expected to perform poorly in the future, while growth stocks, stocks that showed good results in the past, are expected to continue to do well in the future. La Porta et al.,[272] Skinner and Sloan[273] also show that for low book-to-market securities, market

[269] Robert J. Shiller, "From Efficient Markets Theory to Behavioral Finance," Journal of Economic Perspectives, Vol. 17, No. 1, 2003 (Behavioral Finance), pp. 90-91.
[270] Michael Kaestner, "Anomalous Price Behavior Following Earnings Surprises: Does Representativeness Cause Overreaction?" Finance Presses s Universitaires de Grenoble, Vol. 27, No. 2, 2006, p.5.
[271] Werner F. M. De Bondt and Richard Thaler, "Does the Stock Market Overreact?" Journal of Finance, Vol. 40, 1985, p. 804.
[272] Rafael La Porta, Josef Lakonishok, Andrei Shleifer, and Robert Vishny, "Good News for Value Stocks," Journal of Finance, Vol. 52, 1997(Value Stocks), p. 873.

participants overestimate future earnings. These expectations results in underpricing of value stocks, and overpricing of growth stocks. When the overreaction is corrected, value stocks have higher stock returns and growth stocks have low returns.[274]

[273] Douglas J. Skinner and Richard G. Sloan, "Earnings Surprises, Growth Expectations, and Stock Returns, or, Don't Let an Earnings Torpedo Sink Your Portfolio," Review of Accounting Studies, Vol. 7, No. 2-3, 2002, pp. 289-291.
[274] Nguyen, Fetherston and Batten, p. 51.

CHAPTER III

REAL OPTIONS BASED EMPIRICAL RESEARCH ON ISTANBUL STOCK EXCHANGE

3.1 INTRODUCTION

In this empirical research the risk return characteristics of stocks with varying values of embedded growth options is analyzed based on Real Options Theory. Cross-sectional relation of stock returns is placed in an economic perspective. It is discussed that equity return is likely to depend not only on the risk of assets in place, but also on the risk of growth options. The existence of growth options influences the risk-return profile of firms and helps explain the Fama and French factors when firms have different levels of growth prospects. Theoretical framework in which the explanatory power of the Fama and French factors is related with the view on the firm is summarized in Figure 24.

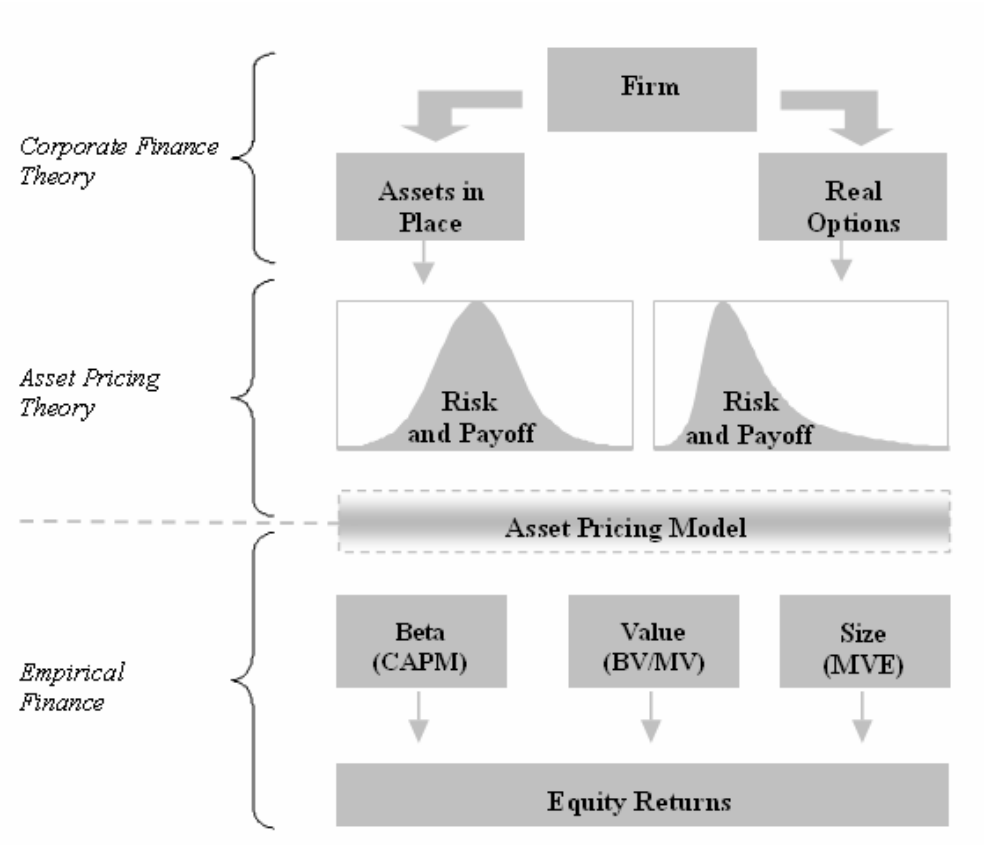
The differences in growth options value across firms induce asymmetry in equity returns, but beta ignores this asymmetry. This could explain why factors such as book-to-market or size are added. In this study the distinguished option characteristics of growth opportunities across firms is related to the return distribution of stocks.

In the stock return performance analyses employed in the research, two main principles derived from Option Pricing Theory are used. First principle is that stocks that have more growth opportunities show different variations in equity returns than do stocks with low growth opportunities mainly because the risk of the portfolio of growth options differs from the risk of the assets in place[275]. This view is related with the book-to-market factor, which is a rough proxy for the level of growth options. Another Option-Pricing-Theory based principle used in this study is the principle that asymmetry in the joint return distribution of stocks seems to exist because of the

[275] Berk, Green, and Naik, p. 1554.

sequential or compound option character of growth options. As was suggested by Knez and Ready skewness in the return distribution over the cross-section of firms can be explained if small growth firms are considered as a portfolio of real options.[276] From this perspective, only a few small growth firms that utilize growth potentials will survive and eventually grow large, while most of firms cannot make the sequential exercise of the growth options. These firms will fail to meet high market expectations, and thus will have low performance. More explanations based on economic fundamentals can be obtained if the joint return distribution over the cross section of firms is examined closer.

Figure 24: Conceptual Framework: Corporate Finance, Asset Pricing and Empirical Finance Theories



Source: Han Smit and Pim Vliet, 2002.

[276] Knez and Ready, pp. 1380-1381.

The main contribution of the empirical research is to provide real options based explanation for the value and size regularities using data from the Istanbul Stock Exchange. It was found that small firms with more growth options have higher return distributions compared to firms with higher amount of assets in place. Sequential or compound option character of growth opportunities explains this observed asymmetry in equity returns of firms with high growth options. The sequential exercise of growth options enables a few firms to benefit from upside potential, while many growth options expire worthless.

The chapter proceeds as follows. The design of the research and proxy for growth options value are discussed in section II. In section III the performance of stocks based on growth options embedded in stock price is empirically investigated in a panel study for the period between January 1997 and December 2008. In order to control for beta, book-to-market and size, portfolios of stocks are ranked two-dimensionally first by a control variable and then by their proportion of growth options. The cross-sectional return distribution of different portfolios is also discussed and analyzed. Section IV discusses the results.

3.2 METHODOLOGY

3.2.1 Design of the Research

In the empirical part of the thesis the relation between growth opportunities and stock returns will be investigated. Stocks will be first sorted along a growth options variable into equally divided portfolios with different level of growths options and then performance of these stock portfolios will be analyzed. It will be tested if sorting along growth options variable results in different return levels between firms with valuable growth options and firms that have few growth opportunities.

One of the proxies widely used in the empirical literature as a proxy for the level of growth options is the book-to market ratio. It implies that attractive growth

opportunities that do not enter the book value, but do enter the market value. Consequently, firms with low book-to-market ratios are classified as growth stocks.[277] But this variable is not directly linked with the level of growth options and was concluded as not "clean" in the study presented by Lakonishok, Shleifer, and Vishny.[278] They state that many different factors other than attractive growth opportunities are reflected in this ratio. A low book-to-market ratio can be caused by excess amount of intangible assets, such as research and development that is not reflected in the accounting book value. A low book-to-market ratio can also describe a natural resource company without attractive growth opportunities, but with high temporary profits, which might have a low book-to-market ratio after an increase in the commodity prices. When future cash flows of a stock, whose risk is low, are discounted at a low rate it may result in a low book-to-market ratio as well. Finally, al low book-to-market ratio may describe an overvalued growth stock. Based on these arguments they conclude that book-to-market ration is not a "clean" variable uniquely associated with economically interpretable characteristics of the firm.

To investigate stock return performance, another proxy for sorting stocks on the level of growth options across firms has to be used since book-to-market ratio is not clean as was mentioned above. A measure for the relative value of growth options that is directly linked to the value of growth options has to be identified. In this study the Smit and Vliet methodology[279] will be followed. The variable used to sort stock returns is the relative growth option value embedded in the stock price, $PVGO / P$.

In practice individual stock returns are not normally distributed, and non-normalities are found in both the cross-section and the time series,[280] but aggregate portfolio returns are often assumed to be normal. In the portfolio approach, the residual variance is lower and will result in portfolio returns that differentiate due to

[277] Larry Lockwood, Wikrom Prombutr and J. David Diltz, "Investment Irreversibility, Cash Flow Risk, and Value-Growth Stock Return Effects," The Financial Review (Forthcoming article), http://www.thefinancialreview.org/PDF/FR0928-Lockwood-Prombutr-Diltz-Investment-Irreversibility-Cash-Flow-Risk-and-Value-Growth-Stock-Return-Effects.pdf (02.08.09), p. 2.
[278] Lakonishok, Shleifer, and Vishny, pp. 1547-1548
[279] Smit and Vliet, p. 5.
[280] Campbell and Siddique, pp. 1263-1264.

systematic variation in underlying economic causes.[281] However, a growing literature contends that portfolio returns are not normal either.[282] Although portfolio returns are not distributed normally, as compared to measuring variable at an individual firm level, measurement of variables at a portfolio level does have advantages. In this study, a dynamic formation process used in the research of Smit and Vliet is performed, in which stocks are re-ranked each year and each stock is put into the most likely portfolio.

When stocks are grouped along PVGO/P, returns that could be explained with beta alone may be generated because growth options variable may be correlated with beta through firm specific discount rate. A higher systematic risk generates a higher value of relative growth option value embedded in the stock price other things being constant. To correct for high correlation between beta and PVGO/P, a two dimensional portfolio approach is used. Since other factors than beta such as size and book-to-market can also have correlation with PVGO/P, relation between PVGO/P and performance, conditioned for the firms' size and book-to-market value is examined by applying additional two-dimensional portfolio setting. To control for other factors than PVGO/P, stocks are firstly sorted into four quintiles on the above mentioned control variables and then sorted into four quintiles on their proportion of present value of growth options value embedded in the stock price. This sorting results in sixteen equally weight portfolios. The main idea behind using portfolio grouping procedure is to control for effects other than PVGO/P.

3.2.2 Variable Estimation

3.2.2.1 Stock Returns

Because stock market anomalies are described in the discrete time investment literature, this study also uses discrete returns, but while using discrete returns two concerns regarding discrete time returns have to be taken into consideration. The first

[281] Fama and French, Section of Expected Stock, pp. 427-430.
[282] Y. Peter Chung, Herb Johnson and Michael J. Schill, "Asset Pricing When Returns Are Non-normal: Fama-French Factors versus Higher-Order Systematic Co-moments," Journal of Business, Vol. 79, No. 2, 2006, pp. 923-924.

is that discrete returns are non-additive over time. To give a better understanding of this issue an example of stock returns of a hypothetical firm is given. The stock prices for the sub-periods t, t+1 and t+2 are assumed to be 10, 5 and 10 units respectively. Monthly returns for the sub-periods t+1 and t+2 turn out to be -%50 and %100, and return for the whole period can be calculated as the sum of two sub-periods: %50. But actual total return is 0. Another issue that has to be taken into consideration is that the discrete return distribution is skewed to the right and becomes more positively skewed for longer periods of time.

To resolve the concerns of non-additivity, a yearly rebalancing in portfolio analysis has to be assumed. That is investors anew their portfolios each year. This assumption makes yearly returns additive in time. Because the data related to control variables used for portfolio sorting are available only on a yearly basis, yearly returns are used instead of the more commonly practiced monthly returns. Thus, rebalancing takes place only once a year. Second, discrete stock returns distribution is not symmetric by nature, varying from -100% to infinity. Even though it is recognized that discrete performance evaluation automatically introduces asymmetry, it will be showed that growth options introduces additional asymmetry. To gain a better understanding of this asymmetry, the effect of outliers on the exhibited mean returns, trimmed means and skewness values are jointly presented.

To investigate the performance of the portfolio of stocks, firstly discrete yearly returns are calculated the as follows:

$$R_{i,T} = \frac{P_{i,T} - P_{i,T-1}}{P_{i,T-1}} \tag{27}$$

where $R_{i,T}$ is the yearly stock return on firm *i* at the end the year *T*, $P_{i,T}$ is the stock price of the firm *i* at the end of the year *T*, $P_{i,T-1}$ is the stock price of the firm *i* at the end the of the year *T-1*. Then the annual average excess returns for each sorted portfolio are calculated as:

$$R_{p,T} = \sum_{T=1}^{n} (R_{i,T} - R_{f,T}) \tag{28}$$

$R_{p,T}$ s the yearly excess stock return of the portfolio composed of *n* firms at the end of the year *T* and $R_{f,T}$ is the twelve-month deposit rate as of the valuation date.

3.2.2.2 Measurement of Growth Options

A company's market equity value can be split into two parts, the discounted value of current earnings generated by assets in place under a no-growth policy plus real options of the firm, also known as the present value of growth opportunities (PVGO). A company's ability to invest future funds in profitable new projects will represent a growth opportunity. If these future investments produce a return in excess of the company's cost of capital, PVGO has positive value:

$$MVE_{i,T} = PVE_{i,T} + PVGO_{i,T} \tag{29}$$

where $MVE_{i,T}$ is the market value of the firm's equity, $PVE_{i,T}$ is the present value of the earnings generated by assets in place under a zero growth hypothesis and $PVGO_{i,T}$ is present value of the growth opportunities

Following from the formula 29 the price of a stock, $P_{i,T}$, can be split into two components: the present value of the current earnings, $PVE_{i,T}$, per share and the present value of the growth opportunities, $PVGO_{i,T}$, per share and find the $PVGO_{i,T}$:

$$PVGO_{i,T}\ per\ share = P_{i,T} - PVE_{i,T}\ per\ share \tag{30}$$

$$\Rightarrow PVE_{i,T}\ per\ share = \frac{EPS_{i,T}}{E(R_{i,T})} \tag{31}$$

By inserting formula (31) into (30), a new formula as follows can be derived:

$$PVGO_{i,T}\ per\ share = P_{i,T} - \frac{EPS_{i,T}}{E(R_{i,T})} \tag{32}$$

where $EPS_{i,T}$ is the current earnings stream per share and $E(R_{i,T})$ is the firm specific discount rate, which is roughly calculated, using the Sharpe Linter Black (CAPM) model, as:

$$E(R_{i,T}) = R_{f,T} + \beta_i (R_{m,T} - R_{f,T}) \tag{33}$$

where $R_{m,T}$ is the yearly market return, which is yearly return on ISE 100 Index at time *T*, $R_{f,T}$ is the one-year risk free interest rate at time *T* as previously defined, β_i is historical beta coefficient of each stock, which is calculated by regressing monthly firm returns of the previous 36 months on monthly market return as shown below:

$$r_{i,t} - r_{f,t} = \alpha_{i,t} + \beta_i (r_m - r_{f,t}) \tag{34}$$

where $r_{i,t}$ is the monthly stock return on firm *i* at the end of the month *t*, $r_{m,t}$ is the monthly return on ISE 100 Index for the month *t* and $r_{f,t}$ is the one-month risk free deposit rate as of the valuation date *t*.

Monthly returns, $r_{i,t}$, are calculated as follows:

$$r_{i,t} = \frac{p_{i,t} - p_{i,t-1}}{p_{i,t-1}} \tag{35}$$

where $r_{i,t}$ is the monthly stock return as described above, $p_{i,t}$ is the stock price of the firm *i* at the end of the month *t*, $p_{i,t-1}$ is the stock price of the firm *i* at the end the of the month *t-1*.

As now the earnings $EPS_{i,T}$, the discount rate $E(R_{i,T})$ and stock price $P_{i,T}$ are known variables, the unknown PVGO value can be calculated. The first variable

used as a proxy for portfolio grouping, $PVGO_{i,T}/P_{i,T}(1)$, based on formula (32), becomes as follows:

$$PVGO_{i,T}/P_{i,T}(1) = 1 - \frac{(E/P)_{i,T}}{E(R_{i,T})} \tag{36}$$

$$\Rightarrow PVGO_{i,T}/P_{i,T}(1) = 1 - \frac{1}{(P/E)_{i,T}\,E(R_{i,T})} \tag{37}$$

$PVGO_{i,T}/P_{i,T}(1)$ is relative growth options value embedded in the stock price calculated using firm specific discount rate, $(P/E)_{i,t}$ is the price-to-earnings ratio of firm *i* at the end of the year *T*, $E(R_{i,t})$ is the firm specific discount rate as of the date of the valuation as previously described.

From the formula 37 presented above it is seen that through the firm specific discount rate, $E(R_{i,t})$, beta is included in the growth options value. High beta increases firm specific discount rate, which in turn decreases present value of current earnings, finally resulting in higher PVGO. This correlation between proxy $PVGO_{i,T}/P_{i,T}(1)$ and β may cause endogeneity effect in the model. To control for the correlation of PVGO with beta, another proxy for relative growth option value embedded in stock price is needed. For this purpose the earnings are discounted using a risk neutral discount rate, which is not correlated with the firm β. The second proxy that will control for endogeneity effect will become as follows:

$$PVGO_{i,t}/P_{i,t}(2) = 1 - \frac{1}{(P/E)_{i,t}\,R_{f,t}} \tag{38}$$

where $PVGO_{i,T}/P_{i,T}(2)$ is the relative real option value embedded in the stock price. $(P/E)_{i,t}$ is the price-to-earnings ratio of firm *i* at the end of the year *T*, and $R_{f,t}$ is the risk-free interest rate, which in this case is the twelve-month risk free deposit rate. The second proxy used for sorting stocks resembles other commonly used variable in stock market anomalies literature: earnings price measure.

3.3 EMPIRICAL RESEARCH

3.3.1 Data

This study includes all nonfinancial firms whose data were offered to the public at Istanbul Stock Exchange. Financial firms are excluded because high leverage that is normal for these firms does not have the same meaning as for nonfinancial firms, where high leverage more likely indicates distress. Firms without available firm specific variables are also excluded from the data. After all adjustments in the data, a total of 144 firms remained.

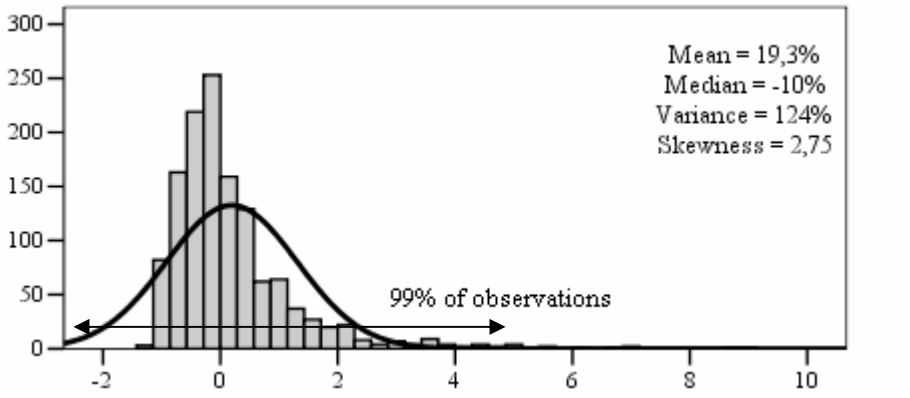
While monthly and yearly stock returns, firm specific accounting ratios are gathered from the website of Istanbul Stock Exchange, one-month and twelve-month risk free deposit interest rates are taken from the website of Central Bank of The Republic of Turkey. The period ranges from January 1997 to December 2008. The beta coefficient of each firm is calculated by regressing firm returns on market return. Since beta of companies at the end of each year is calculated using previous thirty six months, monthly returns of each stock from January 1997 and December 1998 are only used for beta estimations for following years. To investigate performance of portfolio of stocks sorted on the present value of growth options, yearly excess returns of stocks and end-of-the-year firm specific ratios for the period from January 1999 to December 2008 are used. For beta calculation, risk-free interest rate is defined as the one-month Treasury bill rate and ISE 100 Index as the market return; yearly data for the same variables are used to investigate performance of portfolios. For each firm following accounting ratios are obtained: market value of equity (MVE), which is used as a proxy for size, the price-to-earnings ratios (P/E), book-to-market ratios BV/MV. The accounting variables $(\beta, MVE, BV/MV)$ are sorted and matched with returns on one fixed date. Stocks are sorted and allocated in their portfolios at the end of each year. Since the market value of equity in December is used to match the accounting data, the yearly returns from January to the following December are taken.

3.3.2 Cross Sectional Distribution of Returns

To investigate the cross sectional returns of different quintiles, firstly the risk free interest rates are deducted for each stock return of firms included in the data, and then sorted into equally numbered four quintiles on the proxies of growth opportunities embedded in the stock price, namely PVGO/P(1) and PVGO/P(2) presented in the equations 37 and 38. Quintile 1 includes the firms with the lowest proportion of growth options, and firms with the highest growth opportunities are included in the Quintile 4. Yearly excess return data for different quintiles are depicted in the Figures 26 and 27, sorted on PVGO/P(1) and PVGO/P(2) respectively.

The frequency distribution of unsorted excess returns for all yearly returns is shown in Figure 25. Distribution of returns of portfolio of firms sorted on PVGO/P (1) with high growth options is shown in Panel A, and distribution of returns for firms with low growth option is depicted in Panel B of Figure 26. It seems that the cross sectional variance in the yearly excess returns are mainly caused by firms in Panel A.

Figure 25: Distributions of Excess Returns of All Firms



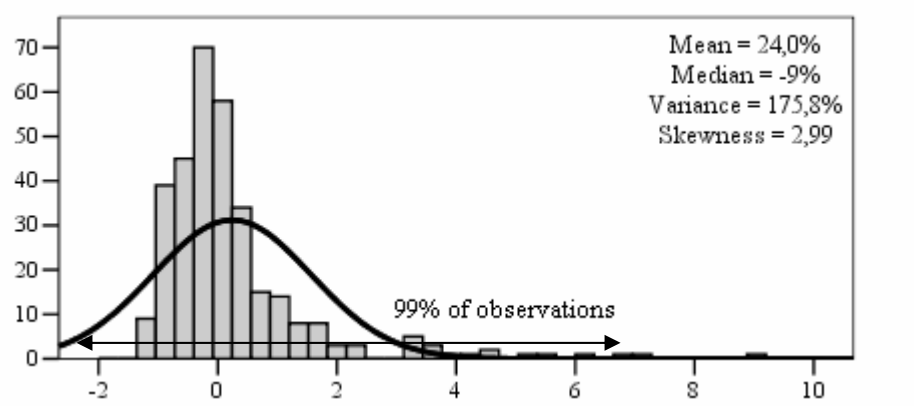
The observations are for the period between January 1999 and December 2008.

Most of the observations for high and low growth options lie between -200% and 663%, -200% and 338% respectively. As was mentioned before discrete returns are skewed to the right by nature, but from the figure it is seen that skewness of the return distribution presented in Panel A is higher than that of in Panel B. While the

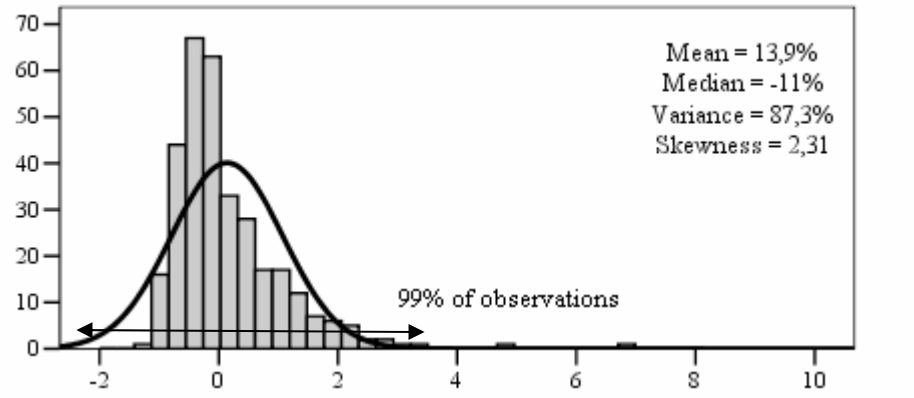
median returns for both distribution do not differ much, mean returns of firms in Panel A, 24%, are almost two fold of mean return of firms in Panel B, 13,9%. The skewness and variance values for return distribution of the firms in Panel A are higher than that of all firms, while the same variable of firms in Panel B is lower.

Figure 26: Return Distributions of Different Quintiles sorted on PVGO/P (1)

A: Yearly Returns of Firms with High PVGO/P (1)



B: Yearly Returns of Firms with Low PVGO/P (1)



The observations are for the period between January 1999 and December 2008.

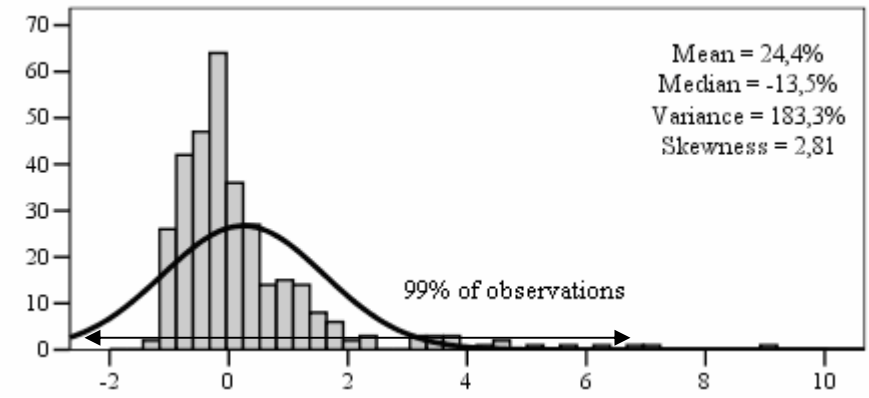
In Figure 27 return distribution of different quintiles sorted on control proxy PVGO/P (2) is presented. All results except median return are in accordance with the results obtained by sorting on PVGO/P(1). Median return in Quintile presented in Panel A, -13,5%, is two times smaller than that of in Panel B, -6,5%. From the presented frequency distributions it seems that while most of the firms that have high

growth opportunities have negative returns, there are some extreme observations that increase their average mean returns.

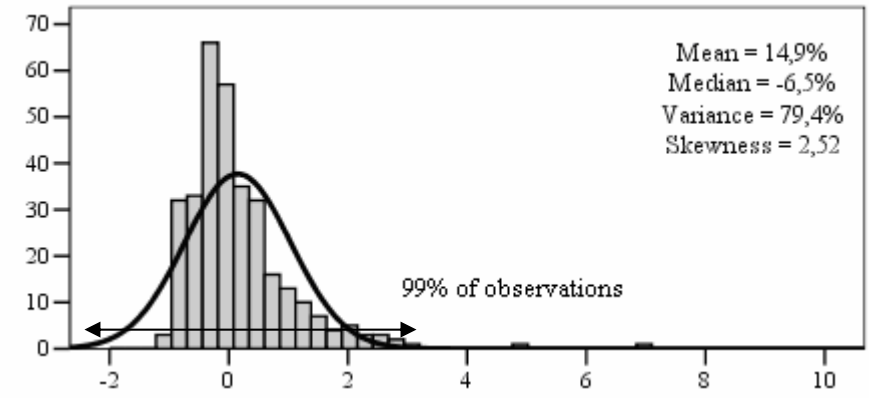
Due to the world financial crisis, the return of many firms in ISE observed downside pattern. To control for this effect, sorting process was done excluding observations for the year 2008. Results found were similar to the previous sortings, except that magnitude of median returns was higher.[283]

Figure 27: Return Distributions of Different Quintiles sorted on PVGO/P (2)

A: Yearly Returns of Firms with High PVGO/P (2)



B: Yearly Returns of Firms with Low PVGO/P (2).



The observations are for the period between January 1999 and December 2008.

[283] See Appendix 2 for descriptive statistics of excess stock returns sorted on both PVGO/P (1) and PVGO/P (2) when the observations of the year 2008 excluded from the data.

3.3.3 Performance Investigation of Stocks Based on Two-dimensional Dynamic Portfolio Grouping

In this part, by using empirical data, the relation between returns and growth options independent of variation in firm specific definitions such as beta, market value of equity and book-to-market is tested. To perform this test a two-dimensional dynamic portfolio grouping approach is chosen. This approach isolates the influence of growth options on the variation in stock returns and enables to control for variation in aforementioned firms specific ratios. As was mentioned before beta may be correlated with the proxy of growth options embedded in the stock price. Because of this relation, returns sorted along the proxy of growth options embedded in the stock price could be explained with beta alone. For this reason, beta is chosen as one of the control variables. Another ratio that is used as a control variable in two-dimensional grouping is the book-to-market ratio, since stocks with low book-to-market values tend to have high growth opportunities. Size is also added as a control variable because it can also be an explaining variable in the variation of growth opportunities held by firms.[284]

At the end of each year excess return of every firm is assigned to four equally numbered quintile portfolios based on control variables: beta, size and book-to-market ratio, and then subdivided into four quintiles portfolios sorted on PVGO/P. This grouping results in sixteen equally numbered portfolios. Average excess return of each portfolio is calculated after they are rebalanced at the end of each year. Statistics of the median, trimmed means, skewness and value of control variables of each portfolio is provided to indicate the robustness of the results. Values of control variables for each portfolio are given in Appendix 3.

The relation between excess returns and present value of growth opportunities embedded in price controlled for beta are shown in Table 3. In the raw labeled "All" in Panel A of Table 3 it is shown that firms in lowest PVGO/P quintile has an

[284] Pablo de Andres-Alonso, Valentin Azorfa-Palenzuela and Gabriela de la Fuerte-Herrero, "Real Options as a Component of the Market Value of Stocks - Evidence from the Spanish Stock Market," Applied Economics, Vol. 37, 2005, pp. 1681-1682.

average return of 16,9%. This value in the second quintile decreases to 15,9%, and then follows a steady ascending patter up to 27,8%. In general high PVGO/P firms earn higher average excess returns independent of beta. The highest returns are observed for portfolios with high beta and growth options. In Panel B it is show that similar results were found after %5 of extreme observations in the data set was trimmed. Median returns are negative in all average PVGO/P(1) quintiles and the lowest for the second, -13,1%, and the forth quintiles, -10,1%, shown in raw "All" of Panel C.

Table 3: Statistics for Yearly Returns of Portfolios Formed by Sorting on Beta and then on PVGO/P (1)

A: Average Yearly Excess Returns					
Beta - PVGO/P	Growth Opportunities Quintile				
	All	1	2	3	4
All	0,193	0,169	0,159	0,165	0,278
Beta 1	0,167	0,081	0,210	0,106	0,272
Beta 2	0,206	0,228	0,122	0,219	0,255
Beta 3	0,222	0,170	0,226	0,133	0,361
Beta 4	0,174	0,196	0,077	0,200	0,224
B: Yearly Trimmed Excess Returns					
All	0,104	0,113	0,088	0,096	0,145
Beta 1	0,084	0,052	0,139	0,034	0,164
Beta 2	0,113	0,199	0,023	0,158	0,117
Beta 3	0,140	0,075	0,162	0,063	0,291
Beta 4	0,079	0,141	0,036	0,128	0,031
C: Yearly Median Excess Returns					
All	-0,100	-0,080	-0,131	-0,078	-0,101
Beta 1	-0,104	-0,105	-0,010	-0,204	-0,076
Beta 2	-0,068	0,011	-0,148	0,006	-0,076
Beta 3	-0,082	-0,124	-0,034	-0,042	-0,115
Beta 4	-0,151	-0,115	-0,180	-0,116	-0,198
D: Skewness of Returns					
All	2,747	2,143	2,063	2,021	3,025
Beta 1	2,418	1,026	1,882	2,501	2,483
Beta 2	2,857	0,970	2,824	1,756	3,201
Beta 3	2,254	3,304	2,005	2,035	1,740
Beta 4	3,355	1,438	1,298	1,891	4,143

When quintiles are sorted on PVGO/P(2)[285] it is observed that the relation between the median returns and growth options are negative. The lowest median returns are attributed to the third,-15,1%, then forth quintiles 11,9%. Panel D shows another indicator of asymmetry in stock returns. It can be seen that portfolios with high growth options have higher value of skewness.

Table 4: Statistics for Yearly Returns of Portfolios Formed by Sorting on MVE and then on PVGO/P (1)

A: Average Yearly Excess Returns					
MVE - PVGO/P	Growth Opportunities Quintile				
	All	1	2	3	4
All	0,193	0,139	0,216	0,176	0,240
MVE 1	0,287	0,232	0,280	0,277	0,359
MVE 2	0,170	0,068	0,169	0,106	0,338
MVE 3	0,213	0,176	0,315	0,209	0,152
MVE 4	0,100	0,078	0,099	0,112	0,109
B: Yearly Trimmed Excess Returns					
All	0,104	0,079	0,147	0,084	0,122
MVE 1	0,179	0,172	0,213	0,134	0,233
MVE 2	0,078	0,035	0,124	0,053	0,178
MVE 3	0,155	0,138	0,248	0,167	0,085
MVE 4	0,011	-0,029	0,014	0,019	0,047
C: Yearly Median Excess Returns					
All	-0,100	-0,108	-0,084	-0,121	-0,091
MVE 1	-0,023	0,024	-0,005	-0,136	-0,025
MVE 2	-0,136	-0,130	-0,152	-0,144	-0,103
MVE 3	-0,075	-0,127	0,008	-0,028	-0,115
MVE 4	-0,144	-0,162	-0,155	-0,130	-0,099
D: Skewness of Returns					
All	2,747	2,317	1,840	3,017	2,987
MVE 1	2,709	1,724	1,777	3,335	2,638
MVE 2	3,113	1,215	1,218	1,689	3,197
MVE 3	1,641	1,258	1,873	1,235	2,030
MVE 4	2,913	3,848	2,562	3,169	1,935

In Table 4 the relation between growth options and returns independent of market value of equity is measured. Market value of equity is used as a proxy for firm size. Average excess return of firms in the PVGO/P Quintile 1 has the lowest

[285] See Appendix 4.

value, 13,9%. The second PVGO/P Quintile has an average return of 21,6%, this value drops to 17,6% for the following Quintile and as predicted reaches maximum magnitude of 24%, in the Quintile with the highest growth options. Small firms in consistence with the findings in empirical literature earn higher returns. Highest returns are earned by small firms with high value of growth options, while big firms with higher amount of assets in place have the lowest returns.

Results for average mean returns are similar both after trimming 5% extreme observations and after sorting on PVGO (2).[286] Another thing that worth mentioning is that quintile of firms with high PVGO/P values are more skewed that other quintiles. Median returns obtained by sorting on PVGO/P(1) shown in the "All" raw of Panel C are negative and have non-linear pattern, but when size ranked data is sorted on PVGO/P(2), reverse and linear relationship between growth options and median returns is observed. PVGO Quintile 4 has the lowest average median return. This pattern holds for all sub-periods.

Statistics for portfolios sorted on PVGO variable after ranked using control variable book-to-market ratio is presented in Table 5. It is provided in the raw "All" of Panel A that average excess returns are higher for firms in the Quintile 4 sorted on PVGO/P. Quintile 1 has an average return of 14%, while firms in Quintile 4 earn average return of 23,2%. Mean return of firms follows an ascending pattern in relation with book-to-market ratio. Average return of firms with the highest book to market ratio is 36,3% and the lowest has 9,1% average return. This pattern holds when data is sorted using PVGO/P(2)[287] as well, but when returns are trimmed explanatory power of growth options in return variation weakens. Skewness results are the same with previous findings. In all cases it was found that firms in the portfolios with high book-to-market and high PVGO variable earn highest returns.

[286] See Appendix 5.
[287] See Appendix 6.

Table 5: Statistics for Yearly Returns of Portfolios Formed by Sorting on BV/MV and then on PVGO/P (1)

A: Average Yearly Excess Returns					
BV/MV - PVGO/P(1)	Growth Opportunities Quintile				
	All	1	2	3	4
All	0,193	0,14	0,207	0,191	0,232
BV/MV 1	0,091	0,033	0,101	-0,031	0,262
BV/MV 2	0,139	0,1	0,266	0,124	0,064
BV/MV 3	0,177	0,177	0,201	0,165	0,167
BV/MV 4	0,363	0,25	0,259	0,508	0,436
B: Yearly Trimmed Excess Returns					
All	0,104	0,102	0,135	0,088	0,12
BV/MV 1	0,005	-0,006	0,021	-0,125	0,16
BV/MV 2	0,066	0,056	0,15	0,066	0,004
BV/MV 3	0,115	0,135	0,154	0,089	0,095
BV/MV 4	0,239	0,225	0,21	0,372	0,278
C: Yearly Median Excess Returns					
All	-0,1	-0,087	-0,106	-0,127	-0,091
BV/MV 1	-0,192	-0,193	-0,174	-0,239	-0,055
BV/MV 2	-0,119	-0,096	-0,034	-0,118	-0,135
BV/MV 3	-0,085	-0,103	-0,036	-0,103	-0,027
BV/MV 4	0,026	0,116	0,019	0,067	-0,076
D: Skewness of Returns					
All	2,747	1,160	2,175	2,955	3,008
BV/MV 1	2,415	1,452	2,161	2,841	2,280
BV/MV 2	2,477	1,343	3,027	1,967	2,270
BV/MV 3	1,843	1,195	1,385	2,278	2,335
BV/MV 4	3,103	0,789	1,335	2,840	2,996

In the Figures 28 and 29 below, most important findings are summarized for better interpretation of the results. In these tables with conditioned statistics of mean and skewness, possible effects due to correlation between beta, market value of equity and book-to-market ration are neutralized, and results presented are independent of control variables. It is shown that the higher the value of PVGO/P variable the higher is the value of skewness of quintiles in all conditioned cases. PVGO Quintile 4 has the highest average return and it's the one which is mostly skewed to the right. This relationship can be the result of the non-normal cross-sectional return distribution. Present value of growth options embedded in the stock

price explains the variation in both average returns and skewness of those returns. This pattern holds when sorted on PVGO/P (2) as well.[288]

Figure 28: Conditioned Mean Returns for PVGO/P (1) Quintiles

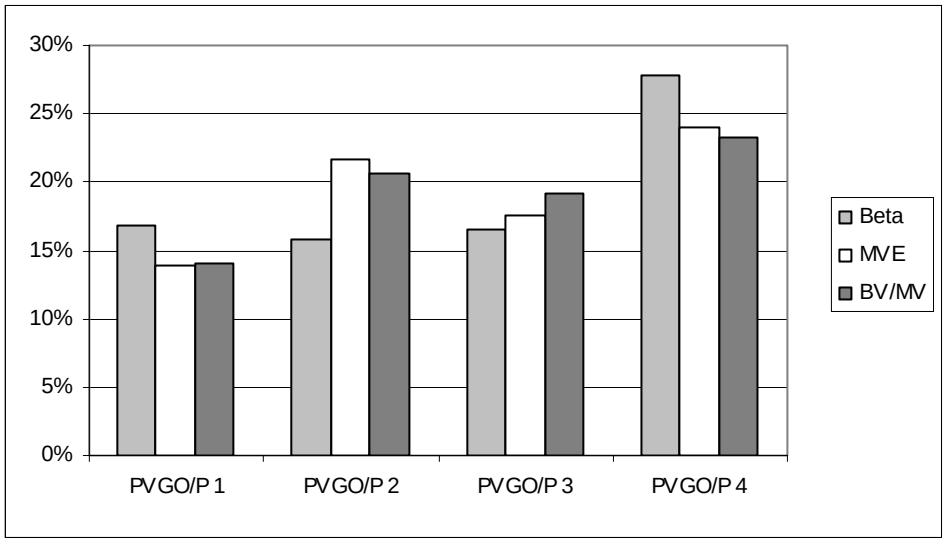
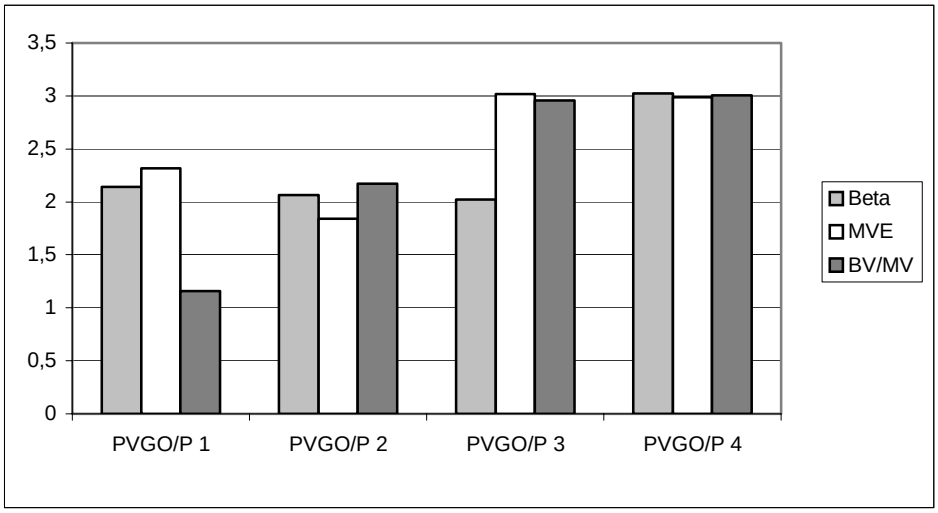


Figure 29: Conditioned Skewness of Returns for PVGO/P (1) Quintiles



[288] See Appendix 7.

3.4 DISCUSSION OF RESULTS

Based on the results of empirical findings the following arguments are proposed. First, there is an asymmetry in the cross-sectional return distribution. Second is that the asymmetry in cross-sectional return distribution is mostly caused by growth options and asymmetry is mostly observed for firms with high value of PVGO. In this study it was found that cross-sectional return distribution is asymmetrical with varying mean and skewness values. This asymmetry is attributed to the existence of growth opportunities across firms. Portfolio performance is strongly influenced by a few extremes. When return distributions are not symmetrical, beta alone cannot fully capture the risk characteristics. Beta overestimates the risk of growth options because it ignores the preference for upwards potential. As suggested in the investment strategy literature sorting on variables other than beta, such as size, value, and momentum is more effective. Extreme returns cannot be predicted by beta alone, but can be predicted if firm specific variables are added. Firms with relatively more proportion of assets in place tend to have less asymmetrical risk return relation. For firms with a low possibility of extreme growth, beta can be a good proxy for risk. But explanatory power of additional factors strengthens when the possibility of the growth potential is high.

To test cross-sectional return variation economically interpretable variable, the present value of growth options embedded in stock price was used. It was found that as the proportion of growth options increases, the average return gets higher and distribution of cross-sectional returns gets more skewed. Thus, proportion of growth options can be used as a proxy for this asymmetry. As was stated by Smit and Vliet, these findings resemble turtle eggs hypothesis suggested by Knez and Ready. The name follows from the fact that mother sea turtles lay many eggs, but few will hatch and fewer still will make it to the ocean.[289] The fact that portfolios of stock with the highest present value of growth opportunities have high mean returns and high skewness implies that mean is typically greater than its median. Because the mean exceeds the median, most of the firms that possess higher amount of growth options

[289] Knez and Ready, pp. 1376-1378.

earn lower returns, while a few firms do extremely well and increase the average return of that quintile. While a few firms benefit by exercising possessed growth options and burst forward each month, most seem to languish because they will not fully utilize their potential and fail to make take necessary actions that would transform growth opportunities into profit. As a result of these reasons some portion of firms in high growth options quintile has lower performance. This observed asymmetry in equity returns of firms with high growth options can be explained by the compound option character of growth opportunities.

It was previously shown in Figures 26 and 27 that firms with high growth opportunities have higher market expectations. Return distribution of firms with higher value of growth options embedded in the stock price have higher value of variance. Firms with high expectation have higher returns, but most of firms fail to meet the same expectations and have lower returns. Cross-sectional return distributions of firms with low and high expectations differ from each other. Firms with low growth opportunities have lower returns and their returns are relatively less skewed as compared to that of firms with high growth options.

This study incorporated insights from real option theory into empirical finance. In this study empirical approach to describe the impact of growth options on the performance of stocks was developed. Firms with more assets in place show a less asymmetrical return distribution, but smaller firms with more growth options show a more skewed return distribution. While many growth options expire worthless, a few firms will be able to successfully exercise their sequential options, and enter a period of extreme growth. Different proportion of growth opportunities across firms changes their risk and return characteristics. The study proposes that the existence of growth options introduces asymmetry in the equity return distribution, which leads to a wrong estimator of mean-variance-based beta. With a dynamic two-dimensional portfolio approach, possible effects of variables that are related to growth options such as beta, size, and book-to-market were neutralized. The risk and pay-off characteristics of growth options appear to introduce distinct differences in the performance of stocks with a varying proportion of growth options value. The

cross-sectional return distribution of stocks with a high proportion of growth options value is characterized by asymmetry. The existence of growth options results in higher mean and more skewed cross-sectional returns. The option view can perhaps provide a better understanding of the regularities that are found in the cross-sectional return distribution in empirical studies.

CONCLUSION

Uncertainty has always been one of the major issues in valuation. But often companies fail to pursue commercial activities or abandon research and development that are surrounded with high level of uncertainty, and consequently considered too risky. This thesis states that uncertainty can create positive value if opportunities are used and dangers are avoided. The valuation of financial investment opportunities using the traditional Discounted Cash Flow often underestimates risky projects because it does not take into account the part of the value of a firm accounted for by the present value of real options. Recently, Discounted Cash Flow has been experiencing challenge from the academic community after option pricing techniques for valuing capital investment projects was introduced. Different approaches for resolving the cash flow problems of DCF emerged. Modified Cash Flow is one of these approaches and is based on DCF. It uses decision tree techniques to explicitly model real options into decision tree, but this approach takes subjective probabilities as inputs, consequently, found results may become subjective as well. Another approach, known as relative valuation, estimates the value of an asset by looking at the pricing of comparable assets relative to a common variable like earnings, cashflows, book value or sales. Although relative valuation methodology is widespread in the practice, it does not capture the company's flexibility to adapt and revise later decisions in response to unexpected market developments and ignores specific information such as: remaining lives of existing products, expected scale of investment in new products and their expected lives, expected profitability of new products and risk, and nonperforming or unwanted assets that can be sold. The last approach, contingent claim valuation approach uses option pricing models to measure the value of assets that share option characteristics and incorporates abovementioned additional information in a company valuation. This thesis supports the latter approach and views a business opportunity of a corporation as a call option. It is argued that some embedded real options may help managers capture upside volatility and avoid downside loss. One of the main ideas presented in the first chapter is that companies can be considered as objects whose value consists of assets-in-place and a portfolio of growth options.

Some of the special issues that come up when valuing real options were also presented in the first chapter. Short introduction to financial options, the determinants of option value, the basics of option pricing and its similarities with real options were explained as well. Later, the general concept of real options, with its different types and applications distinguished in the literature were covered. It was showed that option valuation can also be applied to corporate securities.

In the second chapter, a short review of the portfolio theory and the basic types of asset pricing models employed in the study of stock market behavior were discussed. Models such as Capital Asset Pricing Model, the Conditional CAPM, and the Arbitrage Pricing Theory, Intertemporal CAPM, Consumption based CAPM, and Three Factor Model were covered. Then, Efficient Market Hypothesis, the cornerstone of modern financial theory is explained. Although the Efficient Market Hypothesis was widely accepted by academic financial economists, an equal amount of dissension was proposed by many financial economists and statisticians. Contrary to Efficient Market Hypothesis, some researchers found that stock prices can be partially predicted. They uncovered a wide variety of apparent empirical relations between average stock returns and firm characteristics that are not explained by traditional asset pricing models. The literature concerning these empirical exceptions known as either investment strategies or anomalies and some of their possible explanations were also presented in the second chapter.

In financial market, discoveries of anomalies typically come up from empirical tests that depend on the assumption that security markets are informationally efficient and stock returns behave according to a preset equilibrium model. Anomalies found in the models are often considered to be heralds of a transitional stage toward a new paradigm. New, more accurate explanations of the data must replace the existing simple theoretical models if they are not successful in describing the actual pricing of risky assets within reasonable limits. The existence of anomalies that can not be explained by an asset pricing model may be a result of either market inefficiency which suggests arbitrage opportunities or insufficiency in the underlying asset pricing model. Accordingly, even if anomalies are often

interpreted as evidence of market inefficiency, one has to be cautious in making conclusions about inefficiency because anomalies may also be caused by inadequateness of the underlying asset pricing model. The same case which may be considered as anomalous with regard to one asset pricing model may be compatible with the forecast of other models.

Explanations of anomalies are usually interpreted in different ways such as: rational, tax-based and behavioral. Rational explanation, which generally focuses on the possible errors in the tests of the models, was used in this thesis. Rational explanation was classified into following categories: data snooping, survivorship bias, selection bias, distress risk, and non-normal equity return distribution. This study relates to the latter view and presents an explanation based on real options and asymmetry in return distributions found over the cross section of firms. It is argued that this asymmetry is mainly caused by the existence growth opportunities held by some firms.

In this thesis, empirical approach was developed to describe the impact of growth options on the performance of stocks. The risk return characteristic of stocks with varying values of embedded growth options was analyzed based on real options theory. Cross-sectional relation of stock returns was placed in an economic perspective. In the empirical part of the thesis, it is proposed that the existence of growth options introduces asymmetry in the equity return distribution, which in turn may lead to a wrong estimator of mean-variance-based beta.

Stocks were first sorted along a growth options variable into equally divided portfolios with different level of growths options and then performance of these stock portfolios was analyzed. The variable for growth option used was the present value of growth options embedded in the stock price. With a dynamic two-dimensional portfolio approach, possible effects of variables that are related to growth options such as beta, size, and book-to-market were neutralized. Sorting along growth options variable resulted in different return levels between firms with valuable growth options and firms that have few growth opportunities. It was

observed that the risk and pay-off characteristics of growth options appear to introduce distinct differences in the performance of stocks with a varying proportion of growth options value. The existence of growth options resulted in higher mean and more skewed cross-sectional returns. It was found that firms with more assets in place showed a less asymmetrical return distribution, but smaller firms with more growth options showed more skewed return distribution. In addition, return distribution of firms with higher value of growth options embedded in the stock price turned out to have more variance, which in turn means higher risk.

This study argues that the equity returns depend not only on the risk of assets in place, but also on the risk of growth options. Different proportion of growth opportunities across firms change their risk and return characteristics. The higher value of skewness found in return distribution of firms with more growth options is explained by the turtle eggs hypothesis, which states that while many growth options expire worthless, a few firms successfully exercise their sequential options, and enter a period of extreme growth. The option view can perhaps provide a better understanding of the anomalies that are found in the cross-sectional return distribution in empirical studies. By incorporating future possible outcomes into the stock price's information, real options can be a more sophisticated alternative to traditional discounted cash flow analysis in the valuation of stock market equities and can help explain the Fama and French factors when firms have different levels of growth prospects.

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APPENDICES

APPENDIX 1: Highway and Byways by Paul Klee, 1929

APPENDIX 2: Statistics for Excess Returns

A: Excess Returns Statistics for the Period Jan.1999 - Dec.2008 sorted on PVGO/P (1)

	All	High PVGO/P (1)	Low PVGO/P (1)
N	1296	324	324
Mean	19,26%	23,98%	13,89%
Median	-10,00%	-9,00%	-11,00%
Std. Deviation	111,38%	132,58%	93,45%
Variance	124,06%	175,77%	87,33%
Skewness	2,75	2,99	2,31
Percentiles (99)	478,27%	663,00%	337,50%

B: Excess Returns Statistics for the Period Jan.1999 - Dec.2007 sorted on PVGO/P (1)

	All	High PVGO/P (1)	Low PVGO/P (1)
N	1152	288	288
Mean	30,38%	35,88%	24,10%
Median	-1,00%	-2,00%	-2,50%
Std. Deviation	111,67%	132,30%	93,54%
Variance	124,71%	175,03%	87,50%
Skewness	2,81	3,08	2,38
Percentiles (99)	493,58%	681,09%	362,30%

C: Excess Returns Statistics for the Period Jan.1999 - Dec.2008 sorted on PVGO/P (2)

	All	High PVGO/P (2)	Low PVGO/P (2)
N	1296	324	324
Mean	19,26%	24,36%	14,85%
Median	-10,00%	-13,50%	-6,50%
Std. Deviation	111,38%	135,40%	89,11%
Variance	124,06%	183,34%	79,40%
Skewness	2,75	2,81	2,52
Percentiles (99)	478,27%	663,00%	301,00%

D: Excess Returns Statistics for the Period Jan.1999 - Dec.2007 sorted on PVGO/P (2)

	All	High PVGO/P (2)	Low PVGO/P (2)
N	1152	288	288
Mean	30,38%	35,97%	24,70%
Median	-1,00%	-4,50%	1,00%
Std. Deviation	111,67%	135,70%	88,74%
Variance	124,71%	184,14%	78,74%
Skewness	2,81	2,85	2,66
Percentiles (99)	493,58%	681,09%	324,92%

APPENDIX 3: Values for Portfolios formed by Sorting on Control Variable (Beta, MVE, and BV/MV) and then on PVGO/P. [290]

A: Portfolios sorted on PVGO (1)

A Beta Values					
Control Variable - PVGO/P (1)	Growth Opportunities Quintile				
	All	1	2	3	4
All	0,785	0,792	0,780	0,778	0,789
Beta 1	0,411	0,441	0,373	0,403	0,427
Beta 2	0,701	0,695	0,708	0,708	0,694
Beta 3	0,874	0,873	0,879	0,856	0,887
Beta 4	1,153	1,159	1,162	1,143	1,148
		B: MVE Values			
All	267291	272877	275083	282314	238891
MVE 1	13391	14486	14075	14461	10540
MVE 2	40065	37601	42490	38798	41370
MVE 3	115827	116387	120510	113087	113325
MVE 4	899882	923032	923257	962910	790329
		C: Book-to-Market Values			
All	0,553	0,426	0,680	0,691	0,415
BV/MV 1	-0,412	-0,947	0,170	0,167	-1,037
BV/MV 2	0,479	0,487	0,485	0,476	0,468
BV/MV 3	0,739	0,749	0,735	0,740	0,732
BV/MV 4	1,406	1,417	1,329	1,382	1,497

B: Portfolios sorted on PVGO (2)

A Beta Values					
Control Variable - PVGO/P (2)	Growth Opportunities Quintile				
	All	1	2	3	4
All	0,785	0,784	0,780	0,785	0,789
Beta 1	0,411	0,465	0,385	0,395	0,399
Beta 2	0,701	0,692	0,716	0,702	0,695
Beta 3	0,874	0,866	0,879	0,868	0,883
Beta 4	1,153	1,113	1,142	1,176	1,180
		B: MVE Values			
All	267291	272918	282120	271745	242382
MVE 1	13391	15012	14107	14217	10226
MVE 2	40065	39474	43701	37701	39384
MVE 3	115827	118640	119599	116015	109055
MVE 4	899882	918546	951072	919048	810861
		C: Book-to-Market Values			
All	0,553	0,568	0,678	0,667	0,300
BV/MV 1	-0,412	-0,271	0,191	0,108	-1,675
BV/MV 2	0,479	0,490	0,498	0,469	0,458
BV/MV 3	0,739	0,747	0,732	0,743	0,734
BV/MV 4	1,406	1,304	1,289	1,347	1,685

[290] In Panel C, average firm sizes of each portfolio of stock are sown in thousand Turkish Liras.

APPENDIX 4: Statistics for Yearly Returns of Portfolios Formed by Sorting on Beta and then on PVGO/P (2)

A: Average Yearly Returns					
Beta - PVGO/P	Growth Opportunities Quintile				
	All	1	2	3	4
All	0,193	0,169	0,149	0,135	0,317
Beta 1	0,167	0,106	0,153	0,103	0,306
Beta 2	0,206	0,194	0,213	0,099	0,318
Beta 3	0,222	0,263	0,177	0,133	0,317
Beta 4	0,174	0,111	0,053	0,205	0,329
B: Trimmed Returns					
All	0,104	0,114	0,086	0,064	0,193
Beta 1	0,084	0,080	0,079	0,029	0,201
Beta 2	0,113	0,136	0,148	0,031	0,183
Beta 3	0,140	0,172	0,111	0,063	0,245
Beta 4	0,079	0,068	0,007	0,132	0,144
C: Median Returns					
All	-0,100	-0,060	-0,064	-0,151	-0,119
Beta 1	-0,104	-0,093	-0,054	-0,204	-0,076
Beta 2	-0,068	0,002	0,019	-0,185	-0,087
Beta 3	-0,082	-0,027	-0,040	-0,092	-0,110
Beta 4	-0,151	-0,121	-0,180	-0,124	-0,204
D: Skewness of Returns					
All	2,747	2,352	2,101	2,107	2,757
Beta 1	2,418	0,951	2,141	2,597	2,265
Beta 2	2,857	2,371	2,177	2,084	2,921
Beta 3	2,254	3,102	2,351	1,968	1,739
Beta 4	3,355	1,359	1,514	1,890	3,580

APPENDIX 5: Statistics for Yearly Returns of Portfolios Formed by Sorting on MVE and then on PVGO/P (2)

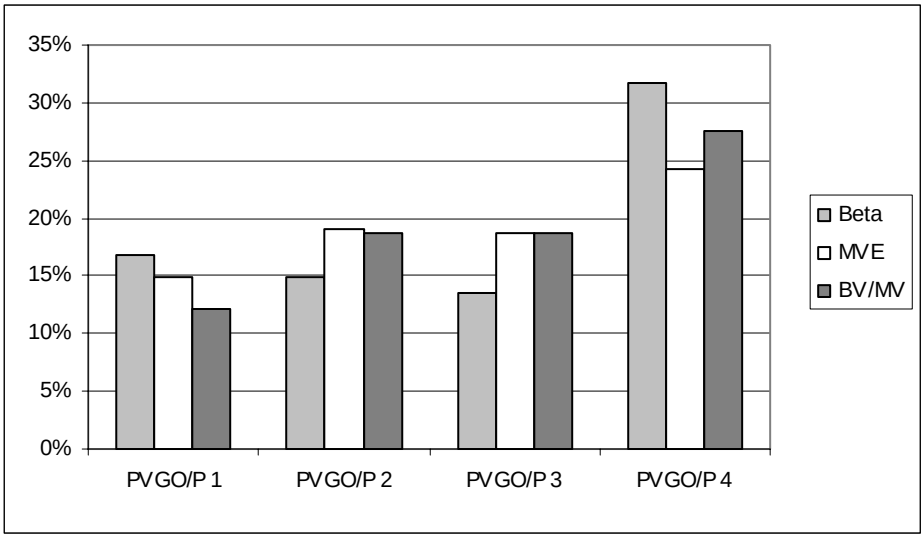
A: Average Yearly Returns					
MVE - PVGO/P	Growth Opportunities Quintile				
	All	1	2	3	4
All	0,193	0,148	0,191	0,187	0,243
MVE 1	0,287	0,168	0,265	0,331	0,384
MVE 2	0,170	0,071	0,146	0,148	0,317
MVE 3	0,213	0,255	0,325	0,127	0,144
MVE 4	0,100	0,098	0,029	0,143	0,129
B: Trimmed Returns					
All	0,104	0,089	0,115	0,120	0,141
MVE 1	0,179	0,105	0,145	0,243	0,260
MVE 2	0,078	0,036	0,109	0,085	0,158
MVE 3	0,155	0,216	0,259	0,099	0,079
MVE 4	0,011	0,001	-0,053	0,054	0,067
C: Median Returns					
All	-0,100	-0,078	-0,047	-0,111	-0,140
MVE 1	-0,023	-0,044	-0,098	0,009	-0,007
MVE 2	-0,136	-0,089	-0,093	-0,204	-0,204
MVE 3	-0,075	-0,027	0,103	-0,116	-0,179
MVE 4	-0,144	-0,153	-0,099	-0,132	-0,171
D: Skewness of Returns					
All	2,747	2,525	2,848	2,175	2,811
MVE 1	2,709	2,028	3,330	1,981	2,661
MVE 2	3,113	1,315	1,010	1,751	3,045
MVE 3	1,641	1,264	1,791	1,054	1,895
MVE 4	2,913	4,001	2,974	2,858	1,789

APPENDIX 6: Statistics for Yearly Returns of Portfolios Formed by Sorting on BV/MV and then on PVGO/P (2)

A: Average Yearly Returns					
BV/MV-PVGO/P	Growth Opportunities Quintile				
	All	1	2	3	4
All	0,193	0,121	0,187	0,187	0,275
BV/MV 1	0,091	0,053	0,119	-0,046	0,239
BV/MV 2	0,139	0,163	0,204	0,071	0,116
BV/MV 3	0,177	0,142	0,121	0,255	0,191
BV/MV 4	0,363	0,126	0,305	0,466	0,555
B: Trimmed Returns					
All	0,104	0,075	0,118	0,090	0,160
BV/MV 1	0,005	-0,018	0,042	-0,130	0,135
BV/MV 2	0,066	0,119	0,084	-0,004	0,065
BV/MV 3	0,115	0,098	0,086	0,183	0,121
BV/MV 4	0,239	0,101	0,269	0,329	0,404
C: Median Returns					
All	-0,100	-0,101	-0,012	-0,162	-0,091
BV/MV 1	-0,192	-0,153	-0,163	-0,307	-0,113
BV/MV 2	-0,119	-0,022	-0,132	-0,151	-0,124
BV/MV 3	-0,085	-0,105	0,002	-0,080	-0,136
BV/MV 4	0,026	-0,089	0,216	0,018	0,017
D: Skewness of Returns					
All	2,748	1,598	2,392	2,778	2,804
BV/MV 1	2,415	2,431	2,259	2,496	2,347
BV/MV 2	2,477	1,359	3,243	2,427	1,595
BV/MV 3	1,843	1,318	1,258	2,057	2,041
BV/MV 4	3,103	1,028	1,023	2,756	2,669

APPENDIX 7: Conditioned Mean and Skewness Values of Different Quintiles sorted on PVGO/P (2)

A: Conditioned Mean Returns for PVGO/P (2) Quintiles.



B: Conditioned Skewness of Returns for PVGO/P (2) Quintiles.