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MASTER'S PROGRAMME

MASTER'S THESIS

Arbitrage Pricing Theory Application in Saudi Arabian Stock Market

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Abstract:

In this study we aim to test the application of the arbitrage pricing theory to the stock market assets of Saudi Arabia. Our study will handle the stocks cited in the TADAWUL stock index over the period of June 2009 up until December 2016. We also identify the factors or macroeconomic variables that can be applied in the Middle East region as follows: Unemployment, interest rate, money supply, industrial production, inflation, exchange rate, and risk premium. We test these 7 factors against several portfolios we built based on each stock's beta. We then find which factors are of significance in affecting the portfolio's price and return.

Keywords: Arbitrage Pricing Theory, APT, Macroeconomic factors.

ÖZ:

Bu çalışmadaarbitrajfiyatlandırmateorisininSuudiArabistanborsavarlıklarınauygulanmasını test etmeyiamaçlıyoruz.Çalışmamız ,2009 yılıHaziranayıboyuncatedavülhissesenediendeksindegösterilenhissesenetleriniAralık 2016'ya kadarelealacaktır.

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Chapter 1:

Introduction:

Asset pricing in the financial world has always been a controversial topic throughout the years. Many researchers tried for decades to build an asset pricing model that would explain the change in an asset price, forecast its returns correctly and fit all the necessary economic criteria. Two of the most widely reputable models are the capital asset pricing model known as CAPM, and the arbitrage pricing theory model known as APT. While many articles were written to compare and whey the pros and cons of each model, there was never a definite answer on which one is more efficient and superior. Yet both models succeed to demonstrate the relationship between return and risk. In general terms, risk and return have an inverse relation. When risk increase, the premium demanded by investors to hold such asset would increase, and by that return increases. The capital asset pricing model was first introduced by Sharpe(1964), Lintner (1965), and then developed by Mossin (1966), Black (1972) and Blume (1973). CAPM is a single factor linear model that is used to estimate the present value of an asset's price by estimating first the beta of the relative asset to the market. Beta is a variable that measures the asset's volatility to the market or portfolio studied. Even though researchers have used this models for decades and it proved its usefulness to investors and hedge fund managers. Yet this model suffers from several restrictions and drawbacks that stop us from using it in our paper. First of all, CAPM assumes that the market is already in equilibrium and that returns on an asset are linearly related to a single factor that is the market itself. Second, it assumes that investors are only concerned with risk return tradeoff. Where investors determine their portfolio by choosing the risk the want to hold that is relatively based on the marketand adjust it by investing into risk free assets. We know in real worlds these assumptions are constantly violated. Even though the model has

proved its efficiency yet we chose to use arbitrage pricing theory in our study. On the other hand, one might suggest the Fama and French (1991) three factor model introduced as an extension to the capital asset pricing model. In the three factor model, CAPM is assumed to be missing two important factors that must be accounted for beside the beta of the market portfolio. The first factor is the size effect that the company's size play where the smaller the company the more its returns can be explained. The second factor is the book to market value ratio which ranks the companies based on their ratio. It is assumed that the higher the ratio, the poorer the return of the company and vice versa.

APT was first introduced by Ross (1976) as an alternative for CAPM and claimed to solve for its drawbacks and restrictions. APT first assumes that returns are related linearly to a set of factors *K*. These factors affect the daily change in price of any asset. Therefore by determining these factors, we can account for the systematic risk that not only affect the asset, but the whole portfolio as well. While APT was built on the basis that returns depends on anticipated, unanticipated changes in the market, systematic and unsystematic risk. This model works on figuring out the systematic risk effect on the returns while ignoring the unsystematic ones that are firm specific and by that called idiosyncratic forces (Roll and Ross, 1995). These idiosyncratic forces are already priced in the asset's prices and returns; therefore their effect is trivial compared to the systematic ones. On the other hand, unanticipated changes are the biggest movers where accounting for their direction and magnitude is challenging, yet measuring their sensitivity to asset's returns is viable by using APT.

Several studies tested APT across several macroeconomic factors, different markets and countries. Chan, Chen, Hsieh (1985) and Chen, Roll, Ross (1986) applied APT on U.S. data using 4 factor models to test if the innovations (macroeconomic variables) affect and are priced

in the asset's price. Other studies applied APT on the UK stock market. Some remarkable work would be by Beenstock and Chan (1988), Clare and Thomas (1994), Poon and Taylor (1991), and Cheng (1995). Antelo and Mangin (2010) applied APT on the Spanish capital market, Abeysekera and Mahajan (1990) on Canadian, U.S. and U.K. stocks. While many researches were conducted mainly on U.S. and U.K. none were conducted in the Middle East region, and especially Arab countries. In the following sections we'll go more in depth in these researches.

In this paper we test the arbitrage pricing theory on one of the most developed and rich country in the Arab world that is Saudi Arabia. First Saudi Arabia has been well known for its oil production since centuries which gave it a competitive edge over the rest of the Arab World. While Saudi Arabia's GDPvalues around 646 billion dollars, its exports value accounts 198 billion dollars in 2016. On the other hand, oil's exports represented between 85% and 90% of its exports prior to 2016. Since 2016 oil prices dropped drastically hitting most of its elite producers and losing billions in dollars of revenues. The reason we chose Saudi Arabia was first its intriguing market composition which relies heavily on oil and commodity productions. Therefore it would have a huge impact on the stock market returns and price movement. Second Saudi Arabia is one of the leading Arabic countries and has the biggest GDP. And finally, we can find all the data necessary in our analysis whereas other countries miss several macroeconomic variables that are either unaccounted for, or relatively only accounted for in recent years. Therefore Saudi Arabia was the first to have a good lump of historical data.

In this paper, we will be using the Saudi Arabian stock index that is called TADAWUL. The index contains 181 stocks that will be later filtered according to the availability of data. In addition, the stocks will be grouped according an equally value weighted index divided across different portfolios and sorted by each stock's beta. The details of grouping will be later

explained in the following sections. Moreover in order to pick our macroeconomic variables, we are basing our choice on previous studies conducted by researchers. Therefore so far we will be using the following factors: Unemployment, interest rate, money supply, industrial production, inflation, exchange rate, imports, exports, gross domestic product, crude oil production and gold price.

Objectives and Contributions of this study:

Despite its abundance, simplicity, and reputation, APT doesn't provide specific guidelines for building the model. While factors are different across industries, some prove significant effect on assets, some doesn't. The significance varies across industries, countries and even stocks in the same index. On the other hand, since APT has been rarely applied to Arab countries, our study represents the first step towards applying APT on Arabic stock markets. Finding the factors that affect the relative assets is a challenging task; in this paper we will set the guidelines to factorsselection in one of the leading Arabic countries. While some of these factors are universal across all industries such as interest rate and money supply. We test their application and significance in the Arab world.

Outline of this thesis:

Following the introductory chapter, comes chapter two that consists of the literature revue. In this chapter we will discuss briefly the rivalry between CAPM, the three factor model and the APT, and then explain the origin and logic behind the theory. Then we will discuss its application and the relative researches conducted throughout the years. While several papers

were written across different countries and industries, each one use different methods or techniques that makes each research unique.

Chapter 3 will consist of describing the Saudi Arabian market, the country's performance (GDP, growth, imports, exports…), and its heavy reliance on oil production. Moreover chapter 4 will consist of the methodology, where we will be grouping the stocks into portfolios, and then select among the different numbers of factors which will be helpful in our study.

In chapter 5 we will be applying and testing the models to check the significance of our result. And then we cite and explain each factor and its significant effect and presence on the prices and returns.

Chapter 6 will consist of the conclusion where we conclude our results and cite which factors can be generally used in any following studies in Arab countries while suggesting topics that can be applied using our research as a reference for further studies.

Chapter 2:

Literature Review:

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2.1. Previous Researches on APT:

Even though APT gained respectable reputation through the decades, it has several drawbacks that made the theory rather challenging. One of the most well-known drawbacks of APT is that the theory doesn't provide detailed and valid guidelines towards factors selection. Although several studies were conducted on different markets, industries, indices and even countries, factors differ in each research due to the lack of those guidelines.

On the other hand we start our discussion by citing several articles that represent the building block of APT, and then we discuss its application across industries. Third we discuss the different articles that argue about factors selection techniques. And finally we discuss the relative articles in the Middle East region.

2.1.1 Early Arbitrage Pricing Theory:

The debut of arbitrage pricing theory was in 1970 by Ross. Even though the theory back then was only theoretical without any valid practical application. The theory only became practically proven as of 1980 in Ross's article. Yet Gehr (1975) was the first to actually test the theory where he studied the return on the stocks of U.S. market. He examined the returns of 41 listed U.S. stocks and 24 industry indices against different factors. He found that at least two of these factors can explain the majority of the changes in the variance of stocks.

Roll and Ross(1980) however were the first to investigate the process of choosing the factors and how to test their relevance. Their study was conducted on U.S. stocks listed in New York and American Exchange. They used daily data from 1962 up until 1972 and stock returns as their dependent variable. The study covered 1260 stocks that were later divided into 42 groups, each group holding 30 different stocks. Their first attempt towards factors selection resulted in a three-step process. The first is by estimating the factor loadings. The second is by running cross sectional regression across all 42 groups. The cross sectional regression resulted in a coefficient that is empirically an estimation of risk premium that the factors hold. And the third step consists of valuing the significance of the coefficients, where one or more should be different than zero and statistically significant so that APT would be applicable and validated. In their study they found that one third of the regressions have at least three of the coefficient significant. Moreover 57.1% have at least two significant coefficients. And finally 88.1% have at least one significant coefficient. Therefore they resulted to the conclusion that APT is applicable and that at least three factors can explain the fluctuations in stock returns.

In later years, several articles tried to compare the efficiency of the arbitrage pricing theory compared to the capital asset pricing model. One of the notable articles was written by Chen (1983) who used daily stock returns of U.S. stock data over the period of 15 years from 1963 up until 1978.He first found that there exists a high and positive correlation between the market index and the factors. Then comparing the models, he found a resemblance between the market portfolio of CAPM and the first factor of APT. Third he found that in order for APT to be applicable, more than one factor should be used. He resulted in a conclusion that CAPM cannot explain the residual terms of APT, whereas APT can explain the residuals of CAPM. Therefore

APT is better at predicting the changes in return. On the other hand he found that the firm variance and size in CAPM has no descriptive influence over the residual terms.

Cho, Elton and Gruber (1984) investigated Roll and Ross's (1980) application of the arbitrage pricing theory to test its robustness. They tried the model using daily return data of stocks registered in the New York and the American stock exchange over the course of 7 years from 1973 until 1980.Yet the betas were generated in three ways, the first through actual return. The second was taken from the fundamental betas of Wilshire associates which are generated through Rosenberg and Marathe (1976) techniques. The third was stimulated from historical data. They grouped the stocks into 58 groups of 30 stocks each alphabetically by ticker symbol.They found that there is a problem in Roll and Ross's application on the factor comparability level. Saying that the estimates obtained by Roll and Ross through the maximum likelihood factor analysis are missing a lot of information and their properties are ambiguous. Their general conclusion was that Roll and Ross's (1980) process has a small propensity in overstating the factors at work.

Another critique that rose to fame was that of Brown and Weinstein (1983). They tested the arbitrage pricing theory using Kruskal's bilinear paradigm. Yet this approach is a special case scenario of APT where factors are pre-specified. They found that Roll and Ross's (1980) approach was in direct conflict with 5 or 7 factors representation. And concluded thatthe 3 factor APT version is precise, and these 3 factors were enough in affecting all the securities returns studied in the economy. While the 5 and 7 factors version was inaccurate.

In addition, the leading critique article was conducted by Dhrymes, Friend and Gultekin (1984). They found that Roll and Ross's application has major drawbacks. Arguing that factors shouldn't be tested based on their pricing influence to the return on the assets. Moreover they argued that

there exists a positive relationship between the numbers of securities that are assembled into groups, and the number of factors needed to explain the fluctuation in returns. Whereas the number of securities increases, the number of factors needed to cover it increases. They used the same list of companies used by Roll and Ross (1980), and conducted the study on 1260 securities grouped into 42 groups of 30 securities each. The study measured the daily return from July 1962 up until December 1972. They concluded that first all securities should be treated symmetrically; therefore analyzing only small groups of the securities give us unclear results. Second, it is impossible to test which factors are actually priced in based solely on the significance of t tests of the coefficients of risk premiums. And finally that the discovery of the number of factors is only relevant to the size of the grouped securities; where the number of securities per group increases, the number of factors needed increases accordingly.

In an attempt to defend their application, Roll and Ross argued that there can be a large number of securities and an equal large number of factors in the same model. Yet the model would be inefficient since most of the non-priced risk factors can be diversified and we can used the most influential priced risk factors to cover the majority of variance in returns.

On the other hand, Dhrymes, Friend, Gultekin and Gultekinanswered back in 1985 by building a model dependent only on the priced risk factors. They conducted the study using daily average returns from 1962 until 1972 on U.S. stock data. And then cross section them to the returns of the same stock groups over the period of 1972 through 1981.In attempt to test the significance of priced in factors across different number of securities and different sizes of groups, they found that the significance is held, yet the sensitivity of the test's outcomes are extremely high in accordance with the number of securities. (New tests of the apt…)

In another study,Cho (1984) tested the arbitrage pricing theory with another approach. He estimated the factor loadings that were consistent between two groups of securities. Since the approach by Roll and Ross (1980) showed that the factors estimated in a group of securities may not have the same factors in another group. This raised red flags on the accountability of the conclusions. Therefore in order to solve this issue Cho (1984) used an inter-battery factors analysis to ensure and constraint that the factor loadings of one group of securities be the same across all other groups.His results showed that five to six groups of inter-group common factors could properly explain the changes in daily returns of the U.S. securities. Therefore he proved that these inter-factors do not depend on the size of the groups. He also concluded that APT could not be rejected since the risk premia was the same all the inter-groups and different from zero.

Chen and Hsieh (1985) took the APT testing to the next level. They tested the firm size effect on the monthly returns generation of APT. They conducted the study on the stocks listen in the New York stock exchange over the period of 24 years from 1953 until 1977. They divided the time line over six intervals, in which the companies were picked based on which firms existed at the beginning and at the ending of the interval and must have price information. Then portfolios or groups of stock were arranged in increasing size order. They used six factors that are; changes in expected inflation, changing risk premium, change in the yield curve (to estimate risk free rate), unanticipated inflation, a market index, and the change in the growth rate of industrial production.

They found that the changing risk premium succeeded to explain the majority of the size effect. And that the change in risk premium shows a great difference between small and large firms. Such results support the fact that smaller firms are risker than larger firms, and get more affected

with economic variables than larger firms. Therefore APT succeed to capture the firm size effect in the model were small firms yield higher average returns for the higher risk they bare.

In addition Chen and Hsieh (1985) found that the model also shows the January effect on returns. January anomaly is due to the great effect that the size firm plays in this month, where more than fifty percent of the magnitude can be found (Keim, 1983).

Gultekin and Gultekin (1987) also experienced the January effect in their study. They used Roll and Ross's maximum likelihood method to find the seven factors needed. They used monthly returns of U.S. stock securities and divided the securities into 30 groups of 7 factors, and 90 stocks for 17 factors. Their results suggested that APT can explain the change in return mostly in the month of January. And that the changes in risk premium hold the majority of the explanation for the change in returns. Therefore they suggested that once the month of January returns are excluded, the APT has no significant results, indicating that APT is only applicable in January.

Cho and Taylor (1987) on the other hand contradicted with these result. They conduct a study on the U.S. securities to test the stability of returns through the year, their correlation coefficients, their covariance and correlation matrices, and finally the APT pricing relationship. They found that the returns generated by factors are mostly stable, yet the correlationcoefficients are not. Therefore there is no January effect on stock returns.

In the following years, APT was tested across different countries. Some of the most successful ones studied the U.K. stock market.

Abeysekera and Mahjan (1987) evaluated two hypotheses to test for the applicability of the arbitrage pricing theory in the U.K. stock market. Their first hypothesis stated that risk free rate is the same as the intercept term of the pricing relation. The second hypothesis stated that there

should be a risk premium attached to each of the factors, since the factors themselves affect the pricing of the asset. They used monthly returns on 40 selected securities listed in the London stock exchange, and then grouped them into seven portfolios. The returns data covered the period of 1971 until 1982. After conducting a maximum likelihood factor analysis to search for factor loadings they successfully validated their first hypothesis that the intercept term is the risk free rate and that it is different from zero. The second hypothesis however wasn't meaningfully validated since the risk premia attached to the factors weren't significantly different from zero. Therefore their results stood against the application of APT in the U.K. market.

Beenstock and Chan (1988) on the other end implemented APT using securities listed in the London stock exchange. They selected 760 securities dividing them into 76 portfolios each consisting of 10 stocks from 1977 until 1983. Their study consisted of eleven factors as follows; The U.K. treasury bill rate, the money supply M3, the general index of retail prices, the general index of wages, the retail volume index, the exports volume index, the gross domestic product, the relative export prices, the fuel and material cost index, the OECD production, and the industrial stoppages. Yet they avoided using factor analysis, instead the factors were explicit. Their results suggest a four factor model for the U.K. securities that efficiently explain the majority of change in returns. The four factors are the interest rate on the Treasury bill, the fuel and materials costs, money supply and inflation. Therefore the sensitivity of expected returns to risk factors resulted with an R^2 of 0.33.

Poon and Taylor (1991) provided another study on the U.K. listed companies. The study covered data from 1965 through 1994. The number of the companies varied from 562 listed companies in 1971 to 1,086 in 1975. In addition the macroeconomic variables selected are as follows: monthly and annual industrial production index, the unanticipated inflation, risk premium, term structure

which is the difference between long term and short term government interest rate, the returns on a value weighted market index, and the returns on an equally weighted market index.

First their results showed that only the sub period of 1968 through 1977 provided significant t-ratios. Second they noticed that the regression analysis is highly sensitive to the number of variables or factors considered. Third, they included lead and lag factors which was not used through previous studies by Roll and Ross. Even though they didn't detect any important relationship, but market efficiency states that the market is capable of forecasting future fluctuations that would lead the economic variables. Fourth, they discovered that the industrial production index is highly seasonal and can be captured through the autocorrelation test of Box-Pierce statistic where the first 24 autocorrelations aren't significant, while the first lag autocorrelation is statistically significant.

On the other hand, Clare and Thomas (1994) conducted a study on the U.K. market to test for order variations when grouping the securities. Their study was focused on factors selection and their affection on the prices of securities. They used 840 U.K. stocks over the period of 12 years until 1990. The securities were divided into 56 portfolios in which 15 stocks were selected per portfolio. Yet two methods of ordering techniques were implemented; the first one was through ranking the stocks by their market beta. The second one was sorting them according to market size.

They used 18 factors in their study that are: Default risk, three month treasury bill rate, real retail sales, gold price, term structure, industrial output, retail price index, oil price, current account balance, MO, unemployment, exchange rate (dollar/pound), debenture and loan red yield,

consolyield/Dy (bonds with no maturity), yield on long term government bonds, private sector bank lending, stock market turnover and yield on short term government bonds.

Their results showed a great difference on the significance of factors between the two sorting techniques. The market value sorted portfolios technique resulted in inflation and a measure of equity market expense was priced in the returns. However in the beta sorted portfolios, they found that several factors were priced over the returns on the market.

2.1.2. Non-US and UK studies:

Hamao (1989) tested the APT on the Japanese market. He used Japanese securities with Japanese macroeconomic factors. He used industrial production, interest rate, oil prices, inflation, investor confidence, foreign exchange rate, term structure, risk premium and unanticipated inflation as his factors. The study was applied on all the stocks listed in Tokyo stock exchange from 1971 to 1988 using monthly returns.They grouped the securities through two market indexes, one value weighted and one equally weighted portfolio. In their model, unanticipated changes in risk premium, expected inflation and unanticipated changes in term structure have the significance effect over the returns. Whereas two factors were not significant and priced in the market; which are oil prices, and foreign exchange rate.

Azeez and Yonezawa (2004) in later years tested APT on the Japanese stock market as well. They included all securities in the Tokyo stock exchange from 1973 to 1998. The study was mainly to assess the applicability of APT pre and post bubble (1979-1990 bubble). They used 13 macroeconomic factors divided into basic time series factors and unexpected ones. The basic factors were: Industrial production, inflation, money supply, call rate, exchange rate, long term bond rate and land price. While the unexpected ones constituted of: unexpected change in money supply, unanticipated inflation, industrial production, term structure, exchange rate, and land

price. Their study supported the applicability of APT on the Japanese stock market returns. They found four factors to be highly significant in explaining the changes in returns which are money supply, exchange rate, inflation and industrial production. They also found that the magnitude of the risk premiums are larger during and post the bubble than the pre bubble ones. That supports the intuition that higher risk premiums are required when the risk of a bubble crash is on the doors.

APT was also tested in India by Dhankar (2005). He conducted his study on the Indian stock market using weekly and monthly returns for 1993 to 2002. The securities amounted to 158 stocks grouped into 15 portfolios. He used principal components analysis to estimate the factors used and tested the models 8, 16, 24 and 32 factors. He sorted the portfolios through industry domains which are: chemicals, food and beverages, machinery, services, textiles, transport, metals, minerals and electricity and cross industry groups. His results suggest that APT is better at explaining the changes in returns of the Indian stock market than CAPM.

Another study from Turkey was conducted by Gunsel, Rjoub and Tursoy (2008). They studied the APT application in the Istanbul stock exchange from 2001 to 2005. They grouped 174 securities into 11 groups based on the industry sectors. They tested the effect of each factor on the different portfolios listed and used 13 factors that are: Money supply, crude oil price, consumer price index, industrial production, gold price, exchange rate, exports, imports, interest rate, GDP, foreign reserve, unemployment rate, and market pressure index. They didn't find a pricing relation between the returns on securities and the macroeconomic factors.

In another study for Tursoy, Gunsel and Rjoub (2009) on the Turkish Stock market, they used different factors and a larger set of stock to apply the Arbitrage Pricing Theory. The number of stocks grew from 174 to 191. Instead of the 13 factors previously used, they used the common

factors suggested in previous studies. The factors were term structure of interest rate, unanticipated inflation, risk premium, real exchange rate, money supply M1 and unemployment.

Opposed to their previous study, Tursoy, Gunsel and Rjoub (2009) found in their new model a relationship between stock returns and the prespecified macroeconomic variables. Money supply, risk premium, interest rate and unanticipated inflation had a significant effect over the change in returns of the Istanbul stock exchange.

In a third study by Tursoy and Awwad (2016), they also applied the APT model on the Turkish stock market, yet this time on the banking sector in particular. The stud covered the banking sector's return index XBNK with three macroeconomic factors. The three factors are interest rate, money supply M2 and the exchange rate. They found a short and long run relationship between the banking index and the latter macroeconomic variables.

On the other hand, going into the Middle East region we barely find any articles applying the arbitrage pricing theory on an Arab country. It's mainly due to the lack of available data and statistical macroeconomic variables. Even though several studies used the capital asset pricing model in several articles, yet CAPM does not need multiple economic factors data. Therefore our study comes as a first step towards applying this model on limited available resources.

2.2. Summary of Previous Research on APT:

Author	Date	Method	Variables	Results
Ross	1970	Arbitrage Pricing Theory	U.S. stock marketinflation, money supply, interest rate, risk premium, gross domestic product, imports, exports, oil prices, industrial	Arbitrage Pricing Theory can be applied on the U.S. stock market

			production	
Gehr	1975	Arbitrage Pricing Theory	U.S. stocks and 24 industry indices	At least two of the factors can explain the majority of the changes in the variance of stocks
Roll and Ross	1980	Arbitrage Pricing Theory	U.S. stocks listed in New York and American Exchange	One third of the regressions have at least three of the coefficient significant
Chen	1983	Arbitrage Pricing Theory	U.S. stock data over the period of 15 years from 1963 up until 1978	the exists a high and positive correlation between the market index and the factors
Cho, Elton and Gruber	1984	Arbitrage Pricing Theory	daily return data of stocks registered in the New York and the American stock exchange over	The general conclusion was that Roll and Ross's (1980) process has a small propensity in overstating the factors at work.
Brown and Weinstein	1983	Arbitrage Pricing Theory	Using Kruskal's bilinear paradigm with 5 to 7 factors	The 3 factor APT version is precise, and these 3 factors were enough in affecting all the securities returns studied in the economy.
Dhrymes, Friend and Gultekin	1984	Arbitrage Pricing Theory	U.S. stocks listed in New York and American Exchange	the number of factors is only relevant to the size of the grouped securities; where the number of securities per group increases, the number of factors needed increases accordingly.
Dhrymes, Friend, Gultekin and Gultekin	1985	Arbitrage Pricing Theory	U.S. stock data	they found that the significance is held, yet the sensitivity of the test's outcomes are extremely high in accordance with the number of securities.
Cho	1984	Arbitrage Pricing Theory	U.S. stock data	APT could not be rejected since the risk premia was the same all the inter-groups and different from zero.
Chen and Hsieh	1985	Arbitrage Pricing Theory	They used six factors that are; changes in expected inflation, changing risk premium, change in the yield curve	They found that the changing risk premium succeeded to explain the majority of the size effect. And that the change in risk premium shows a great difference between small and large firms.

			(to estimate risk free rate), unanticipated inflation, a market index, and the change in the growth rate of industrial production.	
Gultekin and Gultekin	1987	Arbitrage Pricing Theory	U.S. stock securities	The results suggested that APT can explain the change in return mostly in the month of January.
Cho and Taylor	1987	Arbitrage Pricing Theory	U.S. stock securities	They found that the returns generated by factors are mostly stable, yet the correlation coefficients are not. Therefore there is no January effect on stock returns.
Abeysekera and Mahjan	1987	Arbitrage Pricing Theory	U.K. stock securities	APT isnt applicable in the U.K. stock market
Beenstock and Chan	1988	Arbitrage Pricing Theory	U.K. stock securities	The results suggest a four factor model for the U.K. securities that efficiently explain the majority of change in returns. The four factors are the interest rate on the Treasury bill, the fuel and materials costs, money supply and inflation.
Poon and Taylor	1991	Arbitrage Pricing Theory	U.K. Stock market,monthly and annual industrial production index, the unanticipated inflation, risk premium, term structure which is the difference between long term and short term government interest rate, the returns on a value weighted market index, and the	APT is applicable in the U.K. stock market.

			returns on an equally weighted market index.	
Clare and Thomas	1994	Arbitrage Pricing Theory	840 U.K. stocks	they found that several factors were priced over the returns on the market.
Hamao	1989	Arbitrage Pricing Theory	Japanese stock market, industrial production, interest rate, oil prices, inflation, investor confidence, foreign exchange rate, term structure, risk premium and unanticipated inflation	unanticipated changes in risk premium, expected inflation and unanticipated changes in term structure have the significance effect over the returns.
Azeez and Yonezawa	2004	Arbitrage Pricing Theory	Tokyo stock exchange ,Industrial production, inflation, money supply, call rate, exchange rate, long term bond rate and land price.	The study supported the applicability of APT on the Japanese stock market returns.
Dhankar	2005	Arbitrage Pricing Theory	Indian stock market	APT is better at explaining the changes in returns of the Indian stock market than CAPM.
Gunsel, Rjoub and Tursoy	2008	Arbitrage Pricing Theory	Turkey stock exchange, Money supply, crude oil price, consumer price index, industrial production, gold price, exchange rate, exports, imports, interest rate, GDP, foreign reserve,	They didn't find a pricing relation between the returns on securities and the macroeconomic factors.

			unemployment rate, and market pressure index	
Tursoy, Gunsel and Rjoub	2009	Arbitrage Pricing Theory	Turkey stock exchange, term structure of interest rate, unanticipated inflation, risk premium, real exchange rate, money supply M1 and unemployment.	the is a relationship between stock returns and the prespecified macroeconomic variables
Tursoy and Awwad	2016	Arbitrage Pricing Theory	Turkish stock exchange, interest rate, money supply M2 and the exchange rate	They found a short and long run relationship between the banking index and the latter macroeconomic variables.

Table 1

2.2.1 Expected Signs of the sector and macro variable:

Variable	Acronym	Expected Sign	Reference
Term Structure	TS	-	poon&Taylor(1991) and Clare&Thomas(1994) and Hamao(1989)
Inflation	INF	+	Roll&Ross(1980) and Poon&Taylor(1991)
Exchange Rate	EX	+	Hamao(1989) and Azeez&Yonezawa(2004)
Interest Rate	INT	-	Beenstock&Chan(1988)
Market Index	MI	+	Chen&Hsieh(1985) and Chen(1983)
Industrial Production	IP	+	Chen&Hsieh(1985) and gunsel&Rjoub&Tursoy(2008)
Gold	G	+	gunsel&Rjoub&Tursoy(2008)
Risk Premium	RP	-	Gultekin&Gultekin(1987)
Returns on an equally weighted market index	R	-	Poon&Taylor(1991)

Table 2

2.3. Macroeconomic Variables:

In our paper the macroeconomic variables chosen are the same ones analyzed in Gunsel, Rjoub and Tursoy's (2008) article that are as follows:

- Treasury bill rate: the rate is considered to be universally the safest short term financial instrument. Since the government debt obligations are always paid and their risk of default is non-existent. The treasury bill of a country's central bank is an indicator of the financial health of the country. The latter indicator gives us insight into the supply provided by the government, the expansion or contraction of the economy and the monetary policy the country is following.
- Unemployment: it has been historically one of the most important indicators of a country's health since it shows the percentage of the working individual, the amount of jobs provided by the government, and the unemployed percentage of its population. The higher the unemployment rate, the more difficult the economic situation is.
- Change in money supply: since money supply is an indicator of how much money the government is printing and circulating in the economy. In addition to giving us an insight on the monetary policy the government is applying.
- Industrial production: the latter is a measure of the output of the industrial sector on the country. The higher the index, the more the country is focusing on its manufacturing, utilities and mining. It is a great indicator of the production power of the country as a whole.
- Gross Domestic Product: GDP shows a whole picture of the state of the economy in a country. It is an accurate measure of the economy's size, growth and potential. Since

GDP basically contains many variables in its calculation, it is important to understand the big picture of the economy before going into its individual sectors.

- Inflation rate: is a rate that shows how prices of goods and services are changing over time. It is the best indicator to show the change in the value of money of a country. As basic as it looks. A high inflation shows high price levels and raises red flags over the country. On the other hand a low inflation rate also raises red flags since it shows the slow and low growth of the economy. Therefore a good analysis of inflation should be done in order to properly analyze a country's performance.
- Change in crude oil production: Saudi Arabia is one of the largest producer and exporter of oil in the world. Since its economy highly relies on oil prices, production and trade, this variable should be a critical part of our study. When a country's income rely more than 80% on a single output of production, the price of the latter can grow or destroy their whole economy.
- Change in imports: for a country as rich as Saudi Arabia, it is important to notice what the country imports. Any shortage if the economy can easily be imported and outsourced. Therefore what does the country heavily rely on importing? And why doesn't it produce it locally?
- Change in exports: After shedding the light one the importance of crude oil production, it is even more important to analyze how much of its production is actually being exported. What are the steps the government follows when it comes to monitoring its exports and reserves of oil?
- Exchange rate: the exchange rate analyzed in this paper is the Saudi riyal versus the United States dollar. This gives us a great insight towards the strength of the country's

currency. The more stable the currency is the better off the country is. Since the United States dollar is one of the most stable currencies in the world, it was used as a base for comparison. On the other hand, the fluctuation in its currency indicates an unstable economy that relies heavily on other country's performance.

- Gold price: Gold has always been a universal factor at which the higher the country's gold reserves, the better the economy. Gold has been used historically to back the currency and money supply of the country. Therefore gold price and its effect on the market of Saudi Arabia is crucial to our study.

Chapter 3:

3.1. Capital Asset Price Model:

The capital asset pricing model was first introduced by Sharpe (1964), Lintner (1965), and then developed by Mossin (1966), Black (1972) and Blume (1973). This model aims to determine the market price of an asset by finding the market price of its relative risk in accordance to the measurement of the risk itself. It's a single factor linear model that uses portfolio valuation and market equilibrium to define the optimal portfolio position between risk and expected return.

In general term, every asset holds two types of risk; systematic and unsystematic risk. While systematic is a firm specific risk that depends on the firm's performance itself. Some examples would be a company having negative profits, receiving a lawsuit, winning or losing certain contracts… This risk can be eliminated through logical diversification in a controlled portfolio. On the other hand, systematic risk is the risk which isn't accounted for. It can be caused my macro and micro economic variables that affect the market as a whole. Therefore predicting its effect, sign and magnitude is rather challenging. Therefore according to CAPM, the risk of a well-diversified portfolio can be described as the market risk of the separate stocks included in the portfolio.

In order for capital asset pricing model to be applied, one must obey to six assumptions determined by Sharpe (1964) and Lintner (1965). The first assumption assumes that investors are risk averse. They demand higher premium or return for a less risky asset. And as the risk increases, the premium required increases accordingly. The second assumption states that borrowers and lenders in the market operate at a set risk free rate. In other words, investors would borrow or lend at the same exact interest rate. The third ones assumes that the market is

frictionless. This means that transactions costs are zero, taxes are unaccounted for or not included in the study, and severe restrictions are imposed on short selling which means that investors can only buy long positions and not short sell an asset. The fourth assumption states that arbitrage opportunities are unavailable. Arbitrage opportunities typically arise from mispricing a certain asset by the market drifters. Underpriced assets and overpriced assets are assumed to be absent in this model. This means investors themselves are price takers, rather than price makers, and they have homogenous expectations about returns. Fifth, the mean and variance represent the portfolio selecting criteria. Where investors decide which portfolio to invest in by looking at the risk they are willing to bear, and the relative expected return they are willing to earn for holding this risk. And finally the sixth assumption states that the numbers of assets are fixed in the market; i.e. all assets are marketable, divisible and accessible to all investors.

As we explained previously CAPM is a single factor model, and this factor is the market itself. Therefore CAPM revolves around the sensitivity of each asset or security to the whole market in a certain country. This sensitivity is referred to as Beta (β), and it's a measurement of the stock's volatility to the market. It is calculated as the covariance between the asset's return and market's return, over the variance of the market's return. Therefore the higher the beta, investors requires a higher expected return for holding such a volatile asset. And the lower the beta, the lower expected return they are willing to take. At β=0, investors are willing to receive an expected return equal to the risk free rate. Theoretically, risk free rate has always been considered to be the return on a 3 month treasury bill; empirically considered the riskless asset in the market since it's a short term maturity bill and sold by the government. On the other hand, according to Roll (1970), he found that that Treasury bill rates doesn't follow a random walk, which means they

are serially correlated. In other words, variance can only be equal to zero when an asset is available for a single time period. In addition, Treasury bills hold a reinvestment risk, and it's concluded by having an imperfect positive serial correlation throughout the period of three months. In general terms, treasury bills have drivers that affect their price and dividends, which are money supply and nominal interest rate. Even though considered a rather liquid asset, Black, Jensen and Scholes (1972) as well as Fama and Macbeth (1974) who used treasury bills as a risk free asset, found that the intercept in a CAPM exceeds risk free rate rather than being equal to it.

Other glitches in this later model were discovered throughout the years, making it a less applicable model than APT. Some assumptions made by CAPM are rather unreal and doesn't follow the current state of the world. Starting with the assumption that investors are only concerned with the risk return tradeoff while ignoring the specific characteristics of each portfolio and assets. Moreover CAPM assumes that risk can be increased or decreased by simply allocation less or more investment in risk free assets; which is not a viable solution. Third the alleged equality between lending rate and borrowing rate is rather unrealistic and eliminates the effect of several financial institutions that solely rely on the spread between borrowing and lending rate such as banks. Fourth, one of the most important drawbacks of CAPM is the restriction on short selling. While in real terms, short selling is used as a hedging technique by investors to eliminate risk, and it's a vital process to assure equilibrium between long and short position to achieve a market's equilibrium. Therefore by eliminating short selling, the linearity of CAPM becomes violated (Ross, 1977). Fifth, eliminating transaction costs is inappropriate. And finally, assuming all assets are marketable is unrealistic, since newly issued shares and liquidity cannot be ignored.

3.2. Three Factor Model:

The Fama-French three factor model is a model introduced by Kenneth French and Eugene Fama to explain the fluctuations in stock returns. The model itself is an extension of the Capital Asset Pricing Model that changes three important factors. The first factor is by adding the size effect where it's assumed that the small cap stock companies outperform the larger stock companies. The second factor consists of the market risk which is the systematic risk introduced in the capital asset pricing model. And the third factor is the book to market value, where it's assumed that high book to market companies outperforms companies with smaller book to market ratio.

In their first article, Fama and French (1992) only suggested that the book to market values of securities as well as the size effect is both variables that can explain the cross sectional variation in the stock returns. They also assumed that the relation between the CAPM's market Beta and the returns on stocks is flat. Therefore we can find the three factor model under the following equation:

$$R = R_f + \beta_3(K_m - R_f) + b_s . S \quad + b_v . H \quad + \alpha$$

Where $R$is the expected return on a portfolio, $R_f$is the risk free rate,$K_m$is the return on the market portfolio, β is the beta, SMB is the small cap minus the large cap companies, HML is the book to market ratio of the companies.

On the other hand, Fama and French (1993) wrote another article where they suggested a five factor model. In addition to their three factor model, they added two factors related to the bond

market. The first factor is related the maturity of the bonds and the second one is related to the default risk. In this model, they found that the bond factors associated with the bond market capture the variation the bonds return except for low grade corporate bonds.

Fama and French (1995) then focused on their initial 3 factor model, and tested the behavior of stock returns in relation to the book to market value of the equities and the size effect. Where they noted that the higher the ratio of book to market value the poorer the earnings, and the lower the ration, it means the stronger the earnings. Moreover they found a strong relation between the size factor and earnings, yet they didn't find an explanation or a relationship between the ratio of book to market and the returns.

In 1996, Fama and French reexamined their three factor model. They stated that changes in return of stocks are related to 7 factors. The first two are of course the size factor and book to market factor. In addition they added earnings to price ration, cash flow to price ratio, past sales growth, short term historical returns, and long term historical returns. In their study they found that the patterns of returns behavior that is unexplainable by the CAPM model is efficiently explained by the three factor model. Their results were consistent with the Arbitrage pricing theory results, and the rational ICAPM

3.3. Arbitrage Pricing Theory:

Arbitrage pricing theory was initially introduced by Ross (1976) following in intuition behind CAPM. Rather than the model being a linear function of one factor that is the market. Ross constructed a model that is also a linear function where price of an asset is driven by *K* factors. These factors represent macroeconomic variables such as inflation, money supply, interest rate, risk premium, gross domestic product, imports, exports, oil prices, industrial production… Initially, APT agrees to the absence of arbitrage opportunities, on the basis that if opportunities arise, investors will exploit and eliminate them. Therefore contrary to the CAPM, it doesn't assume that the market is in equilibrium and doesn't depend on the existence of the market portfolio. Rather it assumes that the market is efficient, and that investors eliminate any arbitrage opportunities in order to reach equilibrium.

In addition to the assumption of no arbitrage opportunities, Ross followed two others suggested by CAPM:

1) The assumption of risk preference accompanied by expected return. Where investors are risk averse, and demand a higher return for holding a risky asset and a lower return when holding a less risky asset.
2) Capital market are in perfect competition and frictionless; i.e. they don't exhibit transaction costs, or account for taxes.

On the other hand, APT has one assumption that isn't mentioned in the CAPM model which is:

3) All investors have homogenous expectations regarding expected return of assets where changes in prices are explained by the set of *K* factors.

Therefore unsystematic risk or firm specific risk can be eliminated through appropriate diversification. Yet systematic risk or undiversifiable risk cannot be eliminated and can be

explained through a set of macroeconomic variables. These variables are the *K* factors that represent the essence of this model and are the proxies used to explain the expected return fluctuations.

The derived formula of APT can be written as:

$$\tilde{R}_{it} = E(\tilde{R}_{it}) + \beta_{i1}\tilde{F}_{1t} + \cdots + \beta_{ik}\tilde{F}_{k} + \tilde{\epsilon}_{it}$$

Or:

$$\tilde{R}_{it} = E(R_{it}) + \sum_{k-1}^{k} \beta_{ik} F_{k} + \tilde{\epsilon}_{it}$$

Where $\tilde{R}_{it}$ is the rate of return of asset *i* at time *t*,

$E(\tilde{R}_{it})$ is the expected rate of return of asset *i* at time *t*,

β_{ik} is the sensitivity of asset *i* to the variation in k factor,

$\tilde{F}_{k}$ is the mean zero k-th factor common to the returns,

$\tilde{\epsilon}_{it}$ is the idiosyncratic component or unsystematic risk of the i-th asset.

The model assumes that asset's returns and unsystematic terms are normally distributed with mean zero and variance 1. And those common factors K are uncorrelated with each other. Therefore we find the following equation:

$$E(\tilde{F}_k) = E(\tilde{\epsilon}_i) = E(\tilde{\epsilon}_i : \tilde{\epsilon}_j) = E(\tilde{\epsilon}_i : \tilde{F}_k) = E(\tilde{F}_k : \tilde{F}_m) = 0$$

3.3.1. Law of large numbers:

On the other hand, in order for this model to be applicable, Ross (1976) recommends that the law of large numbers must be satisfied. The law of large numbers is a probability theorem that states that events with the same likelihood even out given that enough trials are occurred. In APT case, Ross suggested that idiosyncratic risks can be eliminated when weights of investment in a certain portfolio are spread across different assets given that the assets have limited correlation among each other. Therefore diversifying the portfolio across a large number of assets will eliminate the unsystematic risk once the correlation of assets is equal zero. Ross (1976) states that the correl

ation doesn't need to be exactly zero, as long as the correlation is as minimal as possible.

3.3.2. APT's Equilibrium:

As we mentioned earlier market equilibrium can be achieved by eliminating arbitrage opportunities by investors. In a state of equilibrium the portfolio's excess return should be equal to zero. Yet if the return estimated was positive, then there's arbitrage opportunity where investors will buy the portfolio, increasing demand will drive the mispriced assets upward, resulting in an equilibrium state.

Therefore we can derive the following equation:

$$E(R_i) = \lambda_0 + \lambda_1\beta_{i1} + \cdots + \lambda_k\beta_{ik}$$

Where λ_0 will be equal to risk free rate when zero risk investment is available, and $\lambda_k$represent the risk premium of factor K. the formula of $\lambda_k$can be found:

$$\lambda_K = E(Z_k - R_f)$$

Where Z_k represents the return on the portfolio.

Finally in general terms, APT Equation is as follows:

$$E(R_i) - R_f = \left[\bar{\delta}_1 - R_f\right]\beta_{i1} + \cdots + \left[\bar{\delta}_k - R_f\right]\beta_{ik}$$

Where $\bar{\delta}_k$is the expected return of the portfolio given that it's sensitive to only one K, and insensitive to the rest of the factors. Therefore risk premium can be written as:

$$\lambda_K = \bar{\delta}_k - R_f$$

And finally Beta can be calculated through:

$$\beta_{ik} = \frac{Cov(\vec{R}_i, \vec{\delta}_k)}{Var(\vec{\delta}_k)}$$

Where $Cov(\vec{R}_i, \vec{\delta}_k)$ is the covariance between the asset's returns and the linear transformation of the K-th factor. And $Var(\vec{\delta}_k)$ is the variance of the linear transformation of the K-th factor.

Chapter 4:

Saudi Arabia's Market:

4.1. The Oil Market:

For decades, Saudi Arabia has always been one of the leading countries in the world in oil production. This country that is deserted in nature rests on the biggest oil fields in the world, and gained fame across the globe due to its daily oil production and its trading relationships with the world's leading countries. Saudi Arabia produces an average of 12,387 barrels per day which makes it the second largest oil producing country in the world after the United States of America in recent years. According to EIA (U.S. energy information statistic) the country was the leading oil producer from 2002 until 2013 as we can see in figure 1.

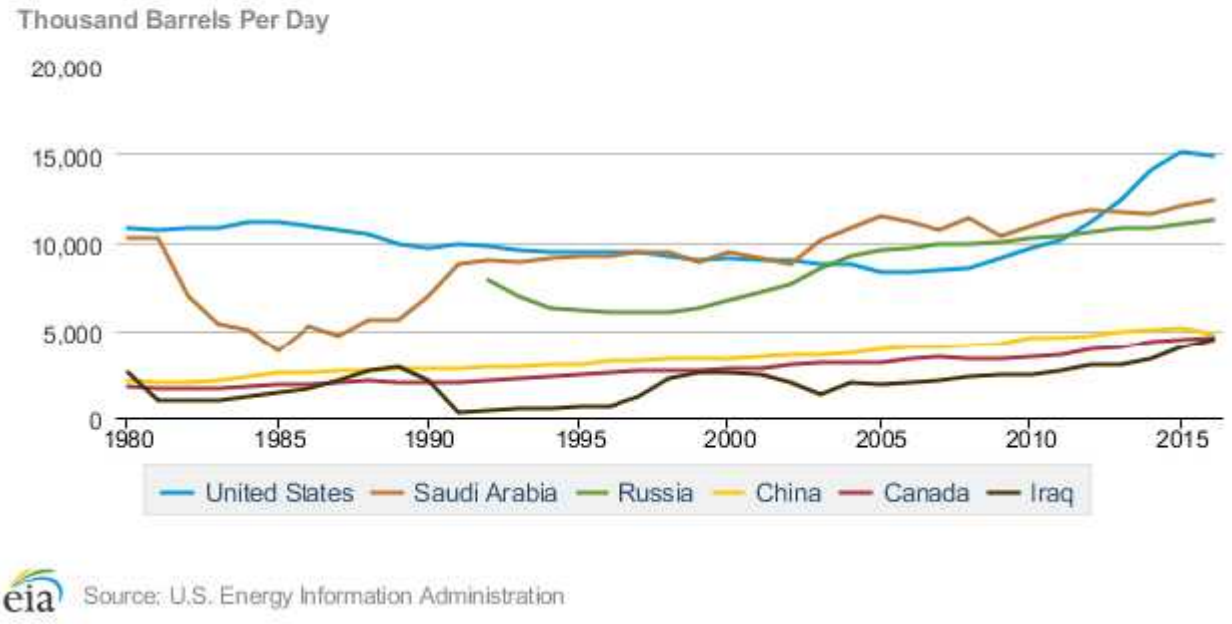

Figure 1

Saudi Arabia is the home of the leading oil producing company Saudi Aramco located in Dhahran. The company is a Californian-Arabian oil drilling company that has the largest reserves of oil in the world. The reason why Saudi Arabia is always associated with oil is because the country exports more than $100 billion worth of crude oil. Oil and its related products consists 62% of the total exports of the country. The major oil importers from Saudi Arabia in descending order by dollar amount of oil imports are China, the United States, India and South Korea. In addition to oil products, Saudi Arabia's leading companies operate in areas of mineral products, chemicals, artificial resins and plastic materials. On the other hand, the country's main and largest imports consist of machinery, appliances, machinery equipment and transport equipment. Therefore we can forecast a large effect of crude oil production as a factor on the returns of the Saudi Arabian securities and market.

The country has been in positive trade balance with imports amounting to $167 billion and exports of $182 billion.

4.2. Prices statistics:

The country has been experiencing an increase in prices on three main domains. The first domain is the whole sale prices, which are the goods that you can buy with the amount of money in your local currency. The wholesale price index is a representative of the price of a basket of goods, and an indicator of the inflation in country. The index of Saudi Arabia reached 102.03 in 2017up from an average of 101 in 2016, and 99 in 2015. Even though the index is at an increasing rate, indicating higher prices for the same sum of goods, yet the country's index is at a better place than the rest of the world. With countries such as U.S. having an index level of 113.4, U.K.

111.10, Russia 640.60 and Euro area 104.90, the country is rather cheaper than the rest of the world for its locals.

The second price domain is the cost of living index. The index has been jumping at an increasing rate of 24% since 2009. While the cost of living index was at 110.5, it reached 137.6 in 2016 indicating an increase in the price of living in Saudi Arabia, that is expected to increase even more in 2017 due to the political conflicts in the Middle East region, and the different sanctions that are being created between the gulf countries.

The third price domain is the real estate price index which shows the prices of houses, buildings and commercial centers. The index has been experiencing a decrease in prices yet at a slow pace. It decreases less than 1% each year since 2015. Therefore we can conclude that the country is getting more expensive each year. In addition it's important to notice that the stats available exist only until 2016. With the country's increasing political problems in the region, alongside the war in Yemen where Saudi Arabia is protecting its borders by conducting airstrikes all over Yemen. The country's military expense is increasing. Adding to that the sanctions newly posed on Qatar that terminated the trades between the two countries, Saudi Arabia is facing an increase in these three domains in 2017.

4.3 Gross Domestic Product:

Saudi Arabia has been experiencing a negative growth in its gross domestic product. Even though GDP peaked in 2014 with a staggering $756.35 billion, it fell to $654.27 billion a year

later, and became $646.44 billion in 2016 as seen in figure 2.

Figure 2

The GDP's downward sloping pace is dueto the country's heavy reliance on oil production and exporting its crude oil abroad. Yet in recent years, oil got a major hit to its prices as of 2015 dropping from more than a $100 to $56 as seen in figure 3. This drop in oil prices caused Saudi Arabia to lose $109.91 billion in GDP with a growth of -1.03% in 2017 down from 6.4% in 2014.

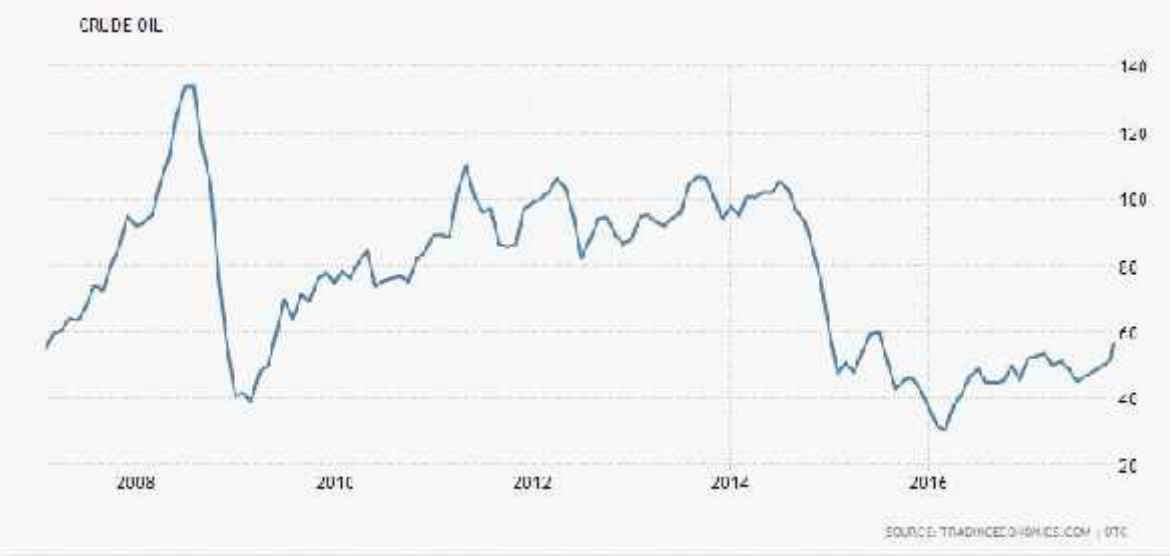

Figure 3

4.4. Economic Indicators:

With the country facing a harder financial situation since the 2014, the economic indicators indicate backward growing economy. The first indicator that is important to notice is unemployment. While Saudi Arabia reached its peak in 2014, it still suffered from a 5.7% unemployment rate, whereas the rate was 5.6% in 2013, and 5.5% in 2012. Therefore as GDP increased to its full potential in 2014, the government couldn't create enough jobs to reduce unemployment. Nowadays, alongside the political struggles in Saudi Arabia, unemployment reached 6% in the second quarter of 2017 raising red flags in the economy. The second indicator is the industrial production in the country. The index reached its all-time high in 2011 yet reaching as low as 2.5% in 2016. This index shows the output of manufacturing, mining and energy companies in the industry. Therefore it indicates the output decreased drastically, which would explain the higher unemployment rate. The third economic indicator is the money supply M2 in the country. The money supply of a country is an indicator of how much stock of currency and liquid instruments are available at a certain date. It contains balances, saving accounts, coins, and checking accounts. It's a measure of liquidity of the economy since M2 exclude cash to measure the efficient liquidity available. M2 has reached its peak in December 2016 with SR 1.643 trillion, and decreased to SR 1.617 in June 2017. The decrease in money supply shows a less liquid economy, yet it's rather higher than previous years with an increase of 107% since 2009. Therefore a low industrial production with high liquidity and funds in the market is a rather worrisome indicator.Fourth indicator would be the exchange rate between Saudi Riyal and the U.S. dollar. The rate has been mainly constant throughout the years varying between 3.74 and 3.76 Saudi riyal for a U.S. dollar. This gives us the idea that the Saudi currency is rather a stable currency that only fluctuates in extreme situations such the financial crisis of 2008 and is

fluctuating in a determined array. The fifth economic indicator is the consumer price index which leads us to the inflation in the country. Inflation reached its high points in 2009 with 11% inflation rate. This value dropped drastically to reach a -0.1% inflation rate at the beginning of 2017. This deflation is expected due to first, its sanctions on Qatar and Yemen, which yields less tradable goods to be exported. And second and the main reason is the decreasing price of oil, which forced Saudi Arabia to stock the oil in reserves rather than selling them at a discount. Therefore the economy is at a deflation which naturally explains the high unemployment levels. Whereas deflation also explains the slower industrial production, since in a state of a deflation the companies work on cost cutting strategies to survive and handle the over produced goods with no relative demand. The index currently contains 179 listed companies across different sectors.

4.5. Tadawul:

The Saudi Stock Exchange is the sole entity in Saudi Arabia that is responsible of listing and trading securities, and it's called Tadawul. The index is called Tadawul all shares index and its abbreviation is TASI. The index started in 1994 and was worth SR 1,282.87, and then it grew to become six times bigger in term of value. The index consists currently of 179 listed companies, with a market capitalization of $569.87 billion. We can divide the index into 20 industries in the following table 1:

Tadawul	
Sectors	Number of Companies
Energy	4
Materials	42
Capital Goods	12
Commercial and Professional Services	2
Transportation	5
Consumer Durables and Apparel	5
Consumer Services	6
Media	2
Retailing	6
Food and Staples Retailing	4
Food and Beverages	12
Healthcare	6
Pharma and Biotech	1
Banks	12
Diversified Financials	4
Insurance	33
Telecommunication Services	4
Utilities	2
REITs	7
Real Estate Management	10
Total	179

Table 3

We can see the industry's heavy reliance on material companies that are mainly oil mining companies and insurance companies. In our study we will only be using the companies that provide financial records over the time period of 2009 through 2016. Joint companies, acquisitions and stock splits will not be considered even though they're rare in the Tadawul index.

On the other hand, looking at the Tadawul index performance, we can find that the index gained 440.42% since its inception. The index increased from SR 1,282.87 in 1994 to reach SR 6,933.09

in November 2017. In addition, the index reached its peak in February of 2006 to become SR 20,966.58, which is a 1,534.34% increase in price since its inception.

Moreover, the overall index performance in recent years has been in a downward slope. Since 2009, the index reached its peak in the end of 2014 and continued to lose value until 2017. After the financial crisis of 2008, the index's value was around SR 4,384.59 and increased up until August 2014 when it reached SR 11,112.12. As of 2014 and the oil crisis repercussions, the index lost 37.41 of its price to reach SR 6,054.38 in November 2017 as we can see in figure 4. Therefore the index itself is accompanying the economic indicators in embodying the backward sloping economy. And it's perfectly represented in the performance of the Tadawul index.

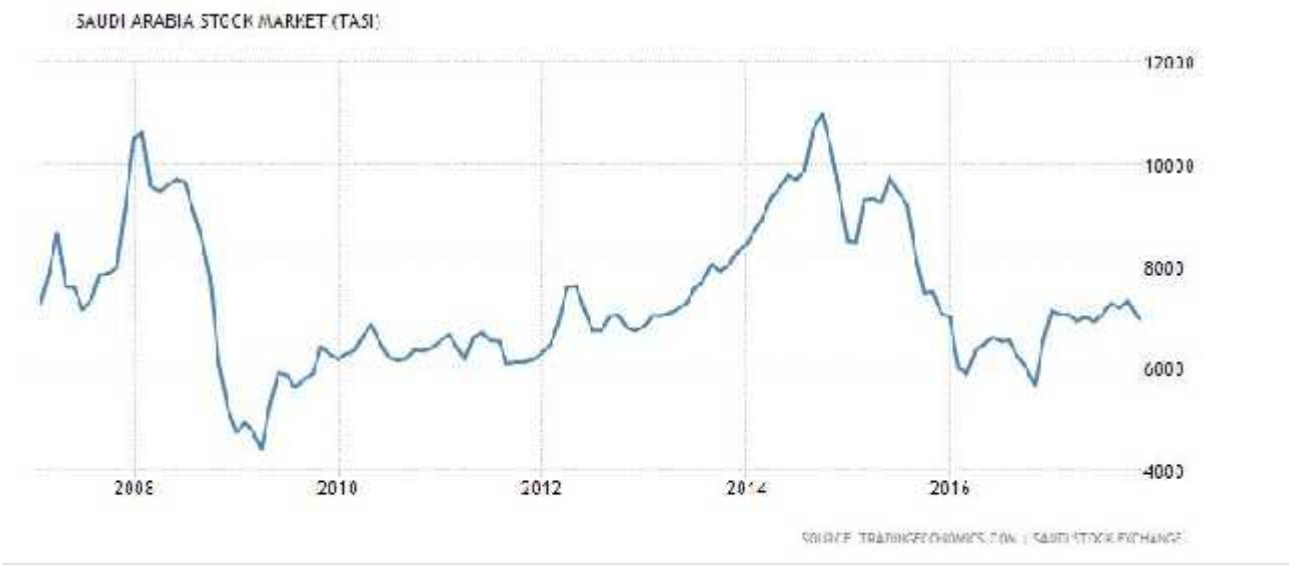

Figure 4

Chapter 5:

Methodology:

5.1. APT Steps:

The arbitrage pricing theory application is composed of three steps. The first step consists of choosing the sample to study and grouping them. The grouping technique will be explained further later on, yet in general terms we divided the Tadawul index into 15 portfolios sector based with different number of stocks in each portfolio. The portfolios range from two stocks to twenty nine stocks in each. The data ranges from June 2009 until December 2016 which results in 91 observations per variable. In addition we chose 11 macroeconomic variables to study following the study by Gunsel, Rjoub and Tursoy (2008).

Step two on the other hand consists of running a regression on each individual stock on the macroeconomic variables over the 7 years. Each individual stock results in an equation with 11 relative coefficients for the macroeconomic variables.

Step three consist of running a cross sectional regression on the average return of the stocks in the same portfolio with the betas we obtained in step two as the independent variables. We end up with a cross sectional regression equation for each portfolio.

5.1.1. Data and Grouping:

We first divided the Tadawul all shares index that consists 179 stocks into sectors as show in chapter 3. Yet the difference this time that we omitted all the stocks that has missing values in the date range of June 2009 to December 2016. We also omitted any stocks that merged,

acquired or dissolved during this period.At last we ended up with the following sectors and number of stocks respectively as shown in table 2:

Sector	Number of Stocks
Energy	4
Material	29
Capital Goods	8
Transportation	4
Consumer Durables	3
Consumer Service	3
Retail	3
Food and Staples	3
Food and Beverage	12
Banks	11
Financials	3
Telecommunication	3
Utilities	2
Real Estate Management	8
Insurance	20
Total	116

Table 4

The return of each stock is calculated using the logarithms of the change in price at t and t-1 as shown in the following equation:

$$R_t = \log(\frac{P_t}{P_{t-1}})$$

On the other hand, the macroeconomic variables chosen are as follows:

- Treasury bill rate: the rate on one month Treasury bill rate has been used as a measure of risk free in the Saudi market.
- Unemployment: the data for this variable was available at a yearly frequency, therefore we transform the yearly data to monthly data.

- Change in money supply: the logarithm of the percentagechange in money supply M1 (in Saudi riyal) has been used by most of the articles applying the APT.
- Industrial production: the data for this variable was also available at a yearly frequency and has been transformed to monthly accordingly.
- Gross Domestic Product: since Saudi is an emerging market, the data can rarely be found monthly, therefore GDP was also found yearly and transformed to monthly. In addition we calculated the percentage change in GPD and used their logarithm for more precision.
- Inflation rate: the inflation rate was found as a percentage change in the consumer price index monthly.
- Change in crude oil production: Since Saudi Arabia is hugely influenced by its oil production and its relative prices. Crude oil production is a must include variable in our study. We used the logarithm of the percentage change in crude oil production as our 7^{th} variable.
- Change in imports: we used the logarithm change in imports over the years.
- Change in exports: we used the logarithm change in exports over the years.
- Exchange rate: we used the exchange rate between Saudi riyal and the United States dollar as our 10^{th} variable. The change in exchange rate levels was calculated to be used.
- Gold price: we used the logarithm change in gold prices in Saudi riyal.

5.1.2. TheRegressions:

The first regression includes the return of individual stocks as an independent variable, and the 11 macro variables as dependent variables. Which gives us the following equation:

$$R_{it} = \propto + \beta_{1i}X_1 + \beta_{2i}X_2 + \beta_{3i}X_3 + \beta_{4i}X_4 + \beta_{5i}X_5 + \beta_{6i}X_6 + \beta_{7i}X_7 + \beta_{8i}X_8 + \beta_{9i}X_9 + \beta_{1\,i}X_1 + \beta_{1\,i}X_1 + \varepsilon_t$$

The betas obtained from the first regression are then grouped with the other betas from the regressions of the stocks in the same portfolio. These betas are then used as independent variables in our cross sectional analysis. In addition our dependent variable will be the average return of the stocks in the same portfolio. Running the cross sectional analysis will give us the following equation of each portfolio:

$$\bar{R}_i = \lambda_0 + \beta_{1i}\lambda_1 + \beta_{2i}\lambda_2 + \beta_{3i}\lambda_3 + \beta_{4i}\lambda_4 + \beta_{5i}\lambda_5 + \beta_{6i}\lambda_6 + \beta_{7i}\lambda_7 + \beta_{8i}\lambda_8 + \beta_{9i}\lambda_9 + \beta_{1\,i}\lambda_1 + \beta_{1\,i}\lambda_1 + \varepsilon_i$$

Where $\bar{R}_i$is the average of the return of the socks in the same portfolio and λ is the reward for bearing the risk.

Chapter 6:

Descriptive statistics:

6.1. Normality of Factors:

First in order to start our study, arbitrage pricing theory imposes an assumption that the data should be normally distributed. Therefore we apply the Jarque-Bera test first to our factors data in addition to some descriptive statistics. Our results are shown in table 3:

Factors	Mean	N	StdDev	Skewness	Kurtosis	Jarque-Bera
Exports	0.002	91	0.01	-0.93	4.24	19.21
Exchange rate	0.002	91	0.01	0.12	3.5	1.21**
GDP	0.005	91	0.01	0.46	12.04	313
Gold Price	0.001	91	0.05	-0.03	2.76	0.22**
Imports	0.001	91	0.03	-0.9	14	471
Inflation	0.03	91	0.01	0.002	1.84	5.01**
Industrial Production	0.03	91	0.04	-0.09	3.73	2.19**
Money Supply	0.007	91	0.01	1.26	5.63	50.56
Oil Production	0.002	91	0.01	0.82	5.86	41.41
Treasury Bills	0.51	91	0.25	2.01	6.31	103.07
Unemployment	0.005	91	0.0001	0.3	2.43	2.58**

Table 5

We first notice that all the means are positive, which indicate that there is a positive but minimal change in the economy as a whole. We start by exports and imports where the mean is positive, yet the skewness is negative. This indicates that there has been more negative change in exports and imports rather than positive. This can be easily referred to due to the drop in oil prices. Since oil has faced a huge plumb in the previous years, it is obvious for a country that Saudi Arabia that heavily rely on its oil production, to face a decline in exports. This results in a negative change in imports to decrease the trade deficit.In addition, the JarqueBera test indicates that the

data for exports is not normally distributed. This can be due to the shocks in the oil market which left many outliers and extreme shifts in data.

Second, exchange rate has a positive mean, skewness, and kurtosis. This shows the heavy density of positive values. In addition, we can see that exchange rates are normally distributed. That can be traced back to the fact that the factor measure Saudi Arabian Riyal versus the United States dollar.

Gross domestic product shows a positive range of data as well. Positive mean, skewness and kurtosis show a fair growth in the GDP. Even though the data for GDP aren't normally distributed yet the factor is a must have factor in our study.

Gold price and industrial production also have a positive mean with negative skewness. The reason is similar to that of exports. In addition both of these factors are normally distributed.

As for inflation, we notice that there has been more positive inflation data than negative ones. The skewness although positive, yet it is minimal. Moreover the data is normally distributed as opposed to the Treasury bill rates. T-bills on the other hand have a positive mean, standard deviation, skewness and kurtosis. Yet the data isn't normally distributed.

Finally money supply and oil production has similar characteristics. Both have a positive mean, skewness, kurtosis and standard deviation. Yet both aren't normally distributed. This can also be explained by the shock in the Saudi market due to its heavy reliance on its oil products. As oil prices dropped, many outliers and extreme data appeared to adjust for the downturn in the economy. Even though some of the factors aren't normally distributed with the Jarque-Bera's, yet the test itself isn't conclusive and other factors can be proved to be normally distributed.

6.2. Normality of Stock Returns:

The general assumption of normality also applies to the stock returns in the TADAWUL stock exchange. In the following tale we provide their mean, skewness, kurtosis, standard deviation and the JarqueBera test for normality:

Table 6

Sector	Company	Mean	N	StdDev	Skewness	Kurtosis	Bera-Jarque
Energy	SARCO	-0.04	91	0.13	1.05	7.56	96.04
	Petro Rabigh	-0.01	91	0.11	-0.15	4.48	8.78*
	Bahri	0.009	91	0.091	-0.44	6.08	0.047*
	Aldrees	0.008	91	0.08	0.5	5	0.01*
Material	ACC	0.002	91	0.08	0.57	4.41	12.59
	Advanced	0.01	91	0.09	0.38	4.36	9.31
	Alujain	0.002	91	0.12	0.23	3.83	3.41**
	APC	-0.005	91	0.12	-0.29	5.44	23.99
	BCI	-0.0009	91	0.09	-0.16	4.63	10.57
	Chemanol	-0.006	91	0.09	-0.31	3.62	2.96**
	EPCCO	-0.003	91	0.06	0.91	7.1	76.00
	FIPCO	0.003	91	0.11	0.44	4.25	9.02*
	Maadaniyah	-0.001	91	0.12	0.09	3.64	1.7**
	Maaden	0.01	91	0.09	-0.06	4.04	4.235**
	Nama Chemical	-0.007	91	0.11	0.1	5.1	17.03
	NGC	-0.01	91	0.09	-0.24	3.95	4.36**
	QACCO	0.001	91	0.05	1.2	6069	73.00
	SABIC	0.003	91	0.07	0.04	5.6	26.40
	SAFCO	0.001	91	0.05	-0.4	4.91	16.30
	SAHARA	-0.001	91	0.1	-0.19	2.99	0.55**
	Saudi Cement	0.006	91	0.07	0.12	3.97	3.84**
	Saudi Kayan	-0.005	91	0.1	0.07	4.07	4.4**
	SIIG	0.0006	91	0.1	-0.7	5.85	39.21
	Sipchem	-0.00045	91	0.1	-1.04	5.04	32.25
	SPCC	0.0034	91	0.066	1.107	6.78	72.96
	SPM	-0.014	91	0.11	0.39	4.25	8.3*
	Tasnee	0.0016	91	0.1	-0.34	3.19	1.95**
	TCC	-0.006	91	0.07	0.5	6.29	45.00

	Yansab	0.007	91	0.08	-0.062	4.99	21.02
	YCC	0.002	91	0.07	0.07	4.57	9.54
	YSCC	-0.0016	91	0.07	-0.31	3.09	1.55**
	ZamilIndust	-0.003	91	0.08	-0.33	4.09	6.28*
	Zoujaj	-0.004	91	0.09	-0.73	4.71	19.43
Capital Goods	ADC	-0.001	91	0.1	-0.86	5.8	41.20
	Al Babtain	-0.005	91	0.11	-0.32	4.09	6.14*
	Amiantit	-0.011	91	0.08	-0.11	3.92	3.44**
	Astra Indust	-0.006	91	0.08	-0.9	5.1	30.60
	MESC	-0.015	91	0.1	-0.66	3.27	7.04*
	Saudi Ceramics	-0.004	91	0.09	0.3	4.7	13.47
	SIECO	-0.003	91	0.15	-0.22	4.8	13.16
	SVCP	0.005	91	0.07	0.29	3.9	4.42**
Transportation	Batic	0.01	91	0.14	0.31	3.71	3.41**
	Budget Saudi	0.08	91	0.088	0.47	3.12	3.4**
	Saptco	0.0057	91	0.1	-0.49	5.06	19.92
	Sisco	0.001	91	0.09	-0.35	2.92	1.89**
Consumer Durables	Alabdullatif	-0.01	91	0.09	-1.66	8.85	171.00
	Fitahi	-0.0017	91	0.1	-0.17	3.5	1.52**
	SIDC	-0.0009	91	0.13	-0.08	6.84	56.16
Consumer Service	AlKhaleej TRNG	0.0008	91	0.1	-0.87	5.83	41.97
	Dur	0.001	91	0.077	-0.38	4.43	10.02
	TECO	-0.0009	91	0.12	-0.01	4.28	6.3*
Retail	AlHokair	0.014	91	0.11	-0.42	5.68	29.91
	Jarir	0.007	91	0.06	0.41	5.62	28.68
	SASCO	0.0041	91	0.11	-0.51	6.62	53.79
Food & Beverages	Aljouf	0.006	91	0.08	-1.02	7.3	86.12
	Almarai	0.013	91	0.05	-0.28	4.23	6.99*
	Food Products Co	0.0009	91	0.12	0.25	3.59	2.344**
	GACO	-0.0029	91	0.12	1.28	9.24	173.00
	HB	0.004	91	0.09	0.28	3.26	1.49**
	Jazadco	-0.001	91	0.11	-0.43	3.84	5.59**
	NADEC	-0.001	91	0.09	-1.6	11.71	327.00
	SADAFCO	0.016	91	0.07	-0.17	2.34	2.12**
	SAVOLA	0.005	91	0.07	-0.2	3.71	2.61**
	SFICO	-0.007	91	0.12	1.03	7.54	94.00
	Sharqiya	4.97E-.05	91	0.14	0.79	5.99	43.57
	TADCO	-0.005	91	0.12	-0.35	5.12	19.02
Banks	Al Rajhi	1.57E-05	91	0.06	-0.08	3.18	0.24**

	Alawal Bank	0.0022	91	0.07	0.33	5.16	19.43
	Albilad	0.006	91	0.08	-0.24	2.4	2.12**
	Alinma	0.0006	91	0.07	0.71	4.59	17.29
	AlJazira Bank	-0.001	91	0.09	0.27	3.83	3.78**
	ARNB	-0.0027	91	0.07	0.8	4.5	18.57
	BSFR	0.0004	91	0.07	0.03	3.79	2.42**
	Riyad Bank	-0.0003	91	0.06	1.65	7.66	124.32
	SABB	-0.0001	91	0.07	0.7	4.19	12.91
	SAIB	0.001	91	0.07	0.48	5.44	26.21
	SAMBA Bank	0.001	91	0.08	0.78	4.66	19.91
Financials	Aseer	0.001	91	0.09	-0.27	3.47	1.99**
	Kingdom	0.003	91	0.1	0.61	7.16	71.52
	SAIC	4.55E-05	91	0.09	-0.66	4.4	14.26
Telecom	Etihad	-0.004	91	0.09	-1.25	9.56	187.00
	STC	0.0035	91	0.06	0.16	4.56	9.72
	ZAIN	-0.01	91	0.1	-0.01	4.78	12.09
Utilities	GASCO	0.003	91	0.06	-0.36	4.44	9.84
	Saudi Electric	0.008	91	0.06	0.16	3.69	2.27**
Real Estate Management	ARDCO	0.009	91	0.08	-0.04	3.29	0.35**
	Dar Alarakan	-0.011	91	0.11	0.16	4.03	4.43**
	Emaar EC	0.005	91	0.1	0.22	3.72	2.75**
	Jabal Omar	0.016	91	0.09	0.11	2.77	0.40**
	MCDC	0.013	91	0.07	1.04	6.11	53.36
	Red Sea	-0.001	91	0.1	-0.59	3.7	7.19*
	SERCO	0.0005	91	0.1	-0.02	4.72	11.23
	Taiba	0.008	91	0.07	0.25	4.81	13.55
Insurance	ACIG	-0.015	91	0.16	0.21	6.76	54.40
	AICC	-0.013	91	0.12	0.33	3.15	1.75**
	Al Ahlia	-0.01	91	0.15	0.09	3.62	1.61**
	Allianz	-0.002	91	0.13	0.56	5.38	26.51
	Arabian Shield	0.003	91	0.15	0.61	4.88	19.12
	ATC	-0.009	91	0.14	1.91	10.93	260.39
	Bupa Arabia	0.02	91	0.1	0.76	4.89	22.48
	Gulf Union	-0.009	91	0.12	0.03	3.37	0.54**
	Malath	-0.014	91	0.12	-0.67	6.06	42.60
	MedGulf	0.004	91	0.14	-1.27	6.14	62.27
	SAAB Takaful	-0.0025	91	0.13	0.56	5.38	26.51
	Sagr Insurance	-0.002	91	0.14	-1.057	5.81	47.10
	SAICO	-0.005	91	0.11	-0.01	3.07	0.02**

	Salama	-0.013	91	0.14	0.43	3.82	5.41**
	Saudi Re	-0.0077	91	0.09	0.36	4.18	7.35*
	Tawuniya	0.012	91	0.11	0.07	3.47	0.93**
	Trade Union	-0.004	91	0.15	-1.17	7.83	109.00
	UCA	-0.0026	91	0.14	-1.05	5.81	47.10
	WAFA	-0.009	91	0.22	0.37	6.62	52.01
	WALAA	-0.0011	91	0.12	0.42	4.67	13.42

From our 116 stock returns, only 49 are normally distributed according to the Jarque-Bera test. Non-normality of data doesn't indicate that the relative returns cannot be used. Rather that the normally distributed ones are more statically significant than the others and will have better beta significance in the APT process.

6.3. Correlation of factors:

We then study the correlation between factors. We find a high positive correlation between imports and GDP which is normal since imports get accounted for in GDP. On the other hand we see a high negative correlation between treasury bills and exports. And finally there exists a positive correlation between inflation with exports, and inflation with GDP. This can be explained by cause effect magnetism. Since when inflation is high, exports tend to increase since it would be more efficient for the market to export their products to decrease inflation.

	Exports	Exchange rate	GDP	Gold Price	Imports	Inflation	Industrial Production	Money supply	Oil Production	Treasury Bill	Unemployment
Exports	1										
Exchange rate	-0.04	1									
GDP	0.31	-0.11	1								
Gold Price	0.12	-0.18	0.02	1							
Imports	0.11	-0.11	0.96	-0.03	1						
Inflation	0.52	-0.24	0.57	0.17	0.52	1					
Industrial Production	0.28	-0.004	0.09	0.05	0.08	0.24	1				
Money Supply	0.24	-0.014	-0.04	0.12	-0.07	0.06	0.11	1			
Oil Production	0.011	-0.153	-0.011	0.005	-0.03	0.1	0.01	-0.19	1		
Treasury Bill	-0.77	-0.01	-0.1	0.007	0.07	-0.25	-0.12	-0.11	-0.05	1	
Unemployment	0.06	0.03	-0.07	-0.03	-0.05	-0.13	0.73	0.1	0.03	0.01	1

Table 7

Chapter 7:

7.1. First Regression Results:

We initially run the first regression in the arbitrage pricing theory process to test the betas of each stock against the factors, and review which factors are of significance in explaining the change in return of the portfolio.

The beta results are available in appendix A. On the other hand, after reviewing the betas and their significance, we came to following sectors and relevant factors in the next table:

Table 8

Sector	Significant Factors
Energy	Exchange Rate, Industrial Production, Unemployment
Material	Exchange Rate, Exports, Unemployment
Consumer Durables	Exchange Rate, GDP, Imports
Food and staples	Exchange Rate, Gold Price, Industrial Production
Food and Beverages	Exchange Rate, Gold Price, Oil Production
Banks	Exchange Rate, GDP, Imports
Financials	Exchange Rate, Exports, Inflation
Real Estate	Exchange Rate, Gold Price, Exports
Insurance	Exchange Rate, Oil production, Industrial Production

It is important to notice that each portfolio is limited with three factors, since no more than three factors are significant in our portfolios. Some sectors were removed because the factor's significance were low or insignificant. In addition, exchange rate has been the only factor proved to be significant in all portfolios. This gives us the idea that exchange rate does affect the market returns in all its sectors. Industrial production was the second highest factor to be abundantly significant in three sectors: Energy, food and staples and insurance. Their significance makes sense in the following sectors since the latter three are highly related with the production levels

of the industry. The third most abundant factor is gold prices. The factor was significant in food and staples, food and beverages and real estate. Even though the reasoning of its significance in such sectors is quite obscure, yet their connection will be later studied in the second step.

7.2. Second Regression Results:

After reviewing their significance we run a cross sectional regression with average returns of the securities as our dependent variable, and the beta we already obtained in step one as our dependent variables. Running this regression will gives us the gammas that explain the relationship between the returns and the factors loading. We follow the same approach used by Tursoy, Gunsel and Rjoub (2008) in their article. They separated each sector with their following significant factors resulting in 11 sectors with factors ranging from six to eleven factors that differs in each sector. In our study we ended up with 9 sectors with three factors each.We test all the sectors by regressing their average returns across all the factors.

We find that exchange rate is the only constantly significant factor across all of our regressions. Therefore this indicates that either arbitrage pricing theory is applicable to all sectors or none at all. We choose to study first the energy sector since Saudi Arabia is well known for its energy production and consumption.

7.2.1 Energy Sector:

We test the energy sector with three factors that are exchange rate, industrial production and unemployment. When running the regression of average returns with the factors, we see that

exchange rate is the only significant factor in explaining the change in returns. We run the two step regression with three factors and we found the following Equation:

AVGRETS = 0.00881917314995 + 0.0138128402572*BETA01 + 2.05094319678e-05*BETA02 - 0.0248558973057*BETA03

These betas correspond to the factor loadings or known as beta hat. We find that the model itself is insignificant with three factors;

Table 9

	gamma_0	gamma_1	gamma_2	gamma_3
Mean	0.008819	0.013813	2.05E-05	-0.024856
Median	0.001229	0.017703	4.34E-05	-0.041324
Maximum	0.323417	0.342028	0.001979	0.626010
Minimum	-0.348148	-0.385866	-0.002342	-0.776995
Std. Dev.	0.108220	0.130420	0.000906	0.279607
Skewness	-0.158064	-0.252722	-0.054676	-0.108375
Kurtosis	3.824294	3.454595	2.967171	2.981491
Jarque-Bera	2.955212	1.752247	0.049426	0.179432
Probability	0.228183	0.416394	0.975590	0.914191
Sum	0.802545	1.256968	0.001866	-2.261887
Sum Sq. Dev.	1.054040	1.530841	7.39E-05	7.036206
Observations	91	91	91	91
t-stat	0.777378	1.010333	0.215847	-0.848016

Therefore we try to apply the arbitrage pricing theory on two factors instead of three, we find the following results:

Table 10

	gamma_0	gamma_1	gamma_2
Mean	0.011912	0.006536	-2.87E-05
Median	0.018243	0.004251	-0.000105
Maximum	0.354056	0.117714	0.001892
Minimum	-0.273000	-0.166313	-0.000858
Std. Dev.	0.091570	0.044760	0.000414
Skewness	-0.022026	-0.303914	1.935224
Kurtosis	4.936502	5.202230	9.213015
Jarque-Bera	14.22626	19.78975	203.1648
Probability	0.000814	0.000050	0.000000
Sum	1.083984	0.594788	-0.002609
Sum Sq. Dev.	0.754660	0.180311	1.54E-05
Observations	91	91	91
t-stat	1.240944	1.392973	-0.661306

On the other hand, when we ran a two factor model, using the same steps as the Arbitrage Pricing theory we find that the model is applicable when no more than two significant factors are chosen. This is due to the high significance of the exchange rate factor, and the low significance of industrial production and unemployment.

Therefore we can conclude that due to the insignificance of the factors across securities and the sector indexes, we can confirm that the arbitrage pricing theory cannot be applied on the Saudi stock market due to several factors that are:

1) Non normality of most of the stock returns.
2) Non normality of the change in the factors over the years.

3) Significance of only one factor out of eleven factors.
4) The instability of the Saudi stock market due to the oil crisis in recent years that caused the market to be infected with financial anomalies.
5) The weak relationship between the factors among each other, where relatively logical relations are absent.

7.2.2. Variables results discussion:

- Treasury bill rate: this rate was one of the least significant variables in our study. This shows us that the companies taken aren't that affected by the fluctuation in the Treasury bill rate provided by the government. This indicates that companies are too wealthy and liquid to worry about few percentage changes in the risk free rate.
- Unemployment: the low significance of unemployment rate was intriguing. Yet researching further in the quality of life Saudis have was surprising. Unemployed Saudi nationals are either too wealthy to work, or apply for financial aid from the government. In addition Saudi nationals when working the simplest and trivial jobs, the minimum wage required is as triple as that of foreigner. Giving the nationals the employment priority as well as high wages shows the quality of life that the Saudi government provide for its civilians.
- Change in money supply: the latter factor was also insignificant except for few companies in the material and real estate sector. This shows us that the amount of money the government decides to print is rather irrelevant or none affecting its local companies.

- Industrial production: the significance, even though minimal for this factor, shows us how highly dependable the country is on its manufacturing companies. Its significance is highly related with the fact that the country is an oil producing country that generates billions of dollars in revenues from its oil extraction alone.
- Gross Domestic Product: the GDP's surprising insignificance was traced back to the fact that GDP depends more on the government companies rather than public companies. Since publically listed companies are mostly non-government ones, the GDP heavily relies on the government related companies that aren't publicly listed. Therefore if it were that the government companies to be publically traded, we would have seen more significance in GDP.
- Inflation rate: inflation rate was also of low significance. The reasoning behind its insignificance is rather ambiguous. But one can related this due to the huge wealth of individuals that would stay unharmed of inflation's drawbacks.
- Change in crude oil production: As explained before, the biggest and most influential oil producing companies are government ones that are not publicly traded. Therefore the low significance of oil production can be traced back to this reasoning.
- Change in imports and exports: imports and exports were stable and slowly growing across all years, even though through the financial crisis of 2008, and the recent oil crisis. The reasoning behind this is that Saudi Arabia have huge oil reserves that would last for decades which makes imports and exports unchangeable even through the oil price crisis.
- Exchange rate: this factor was the most significant factor in our study. This can be traced back to the fact that we used the United States dollar as a base for currency valuation.

Therefore the significance of this factor was predicted due to the heavy reliance of Saudi on its trading industry.

- Gold price: gold prices are the second most significant factor. Due to the universality and impeccable affection of gold prices on all economies, using gold price as macroeconomic variables shows the strength of this indicator across all industries.

7.2.3 Expected Signs of the sector and macro variable:

Sector	Factors	Positive or Negative Effect on Returns
Energy	Exchange Rate Industrial Production Unemployment	Positive Positive Negative
Material	Exchange Rate Exports Unemployment	Negative Positive Positive
Consumer Durables	Exchange Rate GDP Imports	Negative Negative Positive
Food and staples	Exchange Rate Industrial Production Gold Price	Negative Negative Negative
Food and Beverages	Exchange Rate Oil Production Gold Price	Negative Negative Negative
Banks	Exchange Rate GDP Imports	Negative Negative Negative
Financials	Exchange Rate Inflation Exports	Negative Negative Positive
Real Estate	Exchange Rate Gold Price Exports	Negative Negative Positive
Insurance	Exchange Rate Oil Production Industrial Production	Negative Negative Positive

Table 11

Chapter 8:

Conclusion:

The arbitrage pricing theory has always been one of the most successful models to apply in order to understand the relationship between change in stock returns, and the macroeconomic factors surrounding those securities. Even though the model has been successful when applied to developed mature market such as the United States, United Kingdom and Japan, yet the model fail to account for the instabilities faced in Middle Eastern countries. Roll and Ross (1984), Abeysekera, Sarath and ArvindMahajan (1987), Azeez, A.A. and Yonezawa, Y. (2004), Beenstock, M. and K.F. Chan (1986) are few of many scholars that managed to prove the application of the arbitrage pricing theory in the U.S., U.K and Japan.

Economic instability, financial deregulation, political conflicts and the lack of constant financial reporting and supervision made the Middle East a rather gloomy and obscure area to study financial economics. We start by the political conflicts between the Arab countries among each other, and the wars between several political parties inside one country. Great examples of the political struggles are the Syrian civil war, the Saudi Arabia and Yemen war, the revolution in Yemen… adding to that the poor financial reporting required by the countries. Most of the most important data that any country must file monthly are rather missing in several countries. Some of these countries don't even have population statics since the 80s, and other doesn't provide correct economic statistics. Even though the countries are in the developing stages yet the application of financial economics became rather impractical.

In this article we test the application of the arbitrage pricing theory in the Saudi stock market. Saudi Arabia is one of the leading Arab countries in the world, yet the market itself is rather

unstable. Due to the Saudi conflicts in the Middle East, the oil crisis that drained their resources and reserves and the constant change in the economic surrounding of the country, Saudi Arabia became an unstable country itself. In our study we tested eleven factors that are Treasury bill rate, unemployment, imports, exports, inflation, GDP, industrial production, oil production, exchange rate, money supply and gold prices. We used the Tadawul all shares index with 170 shares in total, in which few survived our testing stage.

Our results confirm that the arbitrage pricing theory is rather inapplicable in Saudi Arabia. Yet it's important to notice the statistical significance of exchange rate in explaining the changes in return. Since the exchange rate shows the buying power of Saudi Riyal against the United States Dollar, it is fair to say that the changes in the Saudi Riyal buying power shows a great deal of affection on the Saudi stock market.

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Appendix A:

Stocks Betas:

Sector	Energy			
Company	SARCO	Petro Rabigh	ALDREES	BAHRI
Constant	-1.563888	-1.601724	-0.754178	0.64852
Beta Treasury Bill	0.003368	0.006839	-0.040657	0.006475
Beta Unemployment	273.373	288.6705	148.3165	-101.3536
Beta Money Supply	0.343451	-0.50771	-0.442735	-0.269819
Beta Industrial Production	-0.103778	-0.666933	-0.55463	0.022398
Beta GDP	-0.61267	-0.222161	-2.621219	-2.049293
Beta Inflation	0.993263	0.21022	-0.382359	-1.626419
Beta Oil Production	-0.737074	-0.588986	0.806633	-0.198665
Beta Imports	-0.174748	-0.126107	1.056242	0.616419
Beta Exports	0.15821	0.566366	0.739612	-0.837931
Beta Exchange Rate	-1.871254	-3.511861	-1.093021	-0.837931
Beta Gold Price	-0.414611	-0.387189	-0.02762	-0.136416

Sector	Material			
Company	ACC	ADVANCED	ALUJAIN	APC
Constant	-1.664255	-0.824588	-1.372498	-0.087467
Beta Treasury Bill	0.039167	0.060705	-0.108267	0.076745
Beta Unemployment	287.7207	137.1583	239.8398	25.00418
Beta Money Supply	-1.095157	0.49053	1.72659	-1.046364
Beta Industrial Production	-0.456454	-0.24484	-0.69434	0.076966
Beta GDP	-1.979618	1.775853	5.408472	-6.261403
Beta Inflation	1.768999	1.089997	1.858024	-1.553802
Beta Oil Production	-0.454142	-0.86539	1.008068	-0.252409
Beta Imports	0.350073	-1.249537	-1.637632	2.908452
Beta Exports	1.228381	0.101127	-3.295547	2.381646
Beta Exchange Rate	-0.512342	-2.882577	1.475125	-2.742563
Beta Gold Price	-0.17454	-0.257362	0.014684	-0.341833

Sector	Material			
Company	CHEMANOL	EPCCO	FIPCO	MAADANIYAH
Constant	-0.535734	-0.746659	-1.203074	-1.020264
Beta Treasury Bill	0.002446	-0.012657	0.032673	0.044618
Beta Unemployment	93.3717	134.1671	206.8411	178.9161
Beta Money Supply	-0.709553	0.064737	-1.068239	-0.882172
Beta Industrial Production	-0.342415	-0.275753	-0.182082	-0.238973
Beta GDP	-2.287325	-3.626527	-1.616637	-5.794777
Beta Inflation	1.000493	0.680311	1.652862	1.028635
Beta Oil Production	-0.452275	0.041382	-1.044445	-1.043333
Beta Imports	0.683396	1.416519	-0.22452	1.897605
Beta Exports	0.414127	0.518388	0.588596	2.077413
Beta Exchange Rate	-2.162039	-1.289871	-2.844087	-1.752564
Beta Gold Price	-0.1395992	-0.116956	-0.541547	-0.244082

Sector	Material			
Company	MAADEN	NAMA CHEMICALS	NGC	QACCO
Constant	-0.104502	-0.416939	-0.452465	-0.682297
Beta Treasury Bill	0.066669	0.018803	0.063752	-0.044184
Beta Unemployment	17.30984	68.38609	79.47477	125.0154
Beta Money Supply	-0.722778	-0.754162	0.179375	-0.314714
Beta Industrial Production	-0.052153	-0.126911	-0.198383	-0.301001
Beta GDP	-1.826397	-3.459201	-2.506316	-1.098707
Beta Inflation	0.029553	1.229603	-0.402761	0.688643
Beta Oil Production	-0.66169	-0.641913	-0.563124	-0.308732
Beta Imports	0.366378	0.941258	0.756329	0.362704
Beta Exports	1.744603	1.268886	2.100587	-0.211669
Beta Exchange Rate	-1.243237	-1.81315	2.532377	-0.433345
Beta Gold Price	0.134421	-0.04239	-0.233649	-0.092496

Sector	Material			
Company	SABIC	SAFCO	SAHARA	SAUDI CEMENT
Constant	-0.275737	-0.019948	-0.700522	-0.291522
Beta Treasury Bill	0.002598	-0.016844	0.037318	-0.014507
Beta Unemployment	49.86395	10.02955	126.3618	51.39743
Beta Money Supply	-0.181064	-0.237243	0.003864	-0.3282378
Beta Industrial Production	-0.301178	-0.118226	-0.458895	-0.023025
Beta GDP	0.562526	-1.929823	-1.608523	-1.864341

Beta Inflation	0.353396	-0.25116	0.009777	0.819893
Beta Oil Production	-0.622461	-0.221082	-0.4646005	-0.078298
Beta Imports	-0.171545	1.076339	0.699438	0.835662
Beta Exports	-0.029807	0.846571	0.444985	0.283816
Beta Exchange Rate	-1.892328	-1.27346	-1.807113	-0.917467
Beta Gold Price	-0.037954	-0.166805	-0.042274	-0.071641

Sector	Material			
Company	SAUDI KAYAN	SIIG	SIPCHEM	SPCC
Constant	-1.457047	-0.733449	-0.874876	-0.89924
Beta Treasury Bill	-0.004474	-0.018304	-0.006486	-0.034344
Beta Unemployment	256.7511	131.0752	160.2223	158.3104
Beta Money Supply	-0.065716	-0.265583	0.2497	-0.759631
Beta Industrial Production	-0.776035	-0.478018	-0.593519	-0.255969
Beta GDP	-1.714139	-1.084988	-4.782641	-1.02413
Beta Inflation	1.408079	1.023876	0.658437	1.44713
Beta Oil Production	-0.75084	-0.401107	0.038332	-0.357672
Beta Imports	0.690249	0.585611	1.776984	0.441511
Beta Exports	-0.108347	-0.34799	0.653421	-0.440932
Beta Exchange Rate	-0.680972	-2.0794	-2.426329	-0.408393
Beta Gold Price	-0.071459	-0.2004591	-0.15509	-0.11828

Sector	Material			
Company	SPM	TASNEE	TCC	YANSAB
Constant	-0.187094	-1.602192	-0.561919	-0.218185
Beta Treasury Bill	-0.00593	0.05584	0.09271	-0.00308
Beta Unemployment	39.40851	274.5555	101.1047	39.84966
Beta Money Supply	-0.715703	-0.21847	-0.243877	-0.342601
Beta Industrial Production	-0.235239	-0.713344	-0.128152	-0.32247
Beta GDP	-2.720793	-4.129349	-3.647707	-2.7088078
Beta Inflation	0.381269	2.234871	0.547418	0.945211
Beta Oil Production	-0.082365	-0.301186	-0.338795	-0.470956
Beta Imports	0.816234	1.7247251	1.3119014	1.168791
Beta Exports	1.669817	0.8138	1.119014	0.005356
Beta Exchange Rate	-2.628575	-0.967296	-1.927889	-2.310569
Beta Gold Price	-0.514635	-0.158826	-0.100708	0.02752

Sector	Material				
Company	YCC	YSCC	ZAMIl INDUST	BCI	ZOUJAJ
Constant	-0.772725	-1.0324	-0.249491	-0.792138	-1.324327

Beta Treasury Bill	-0.003765	-0.027555	0.029129	0.207222	0.028756
Beta Unemployment	140.7196	185.6417	55.10557	116.4793	242.3044
Beta Money Supply	-0.698331	-0.584854	-0.295889	-0.6664403	-1.099456
Beta Industrial Production	-0.188623	-0.464245	-0.403356	-0.475169	-0.382475
Beta GDP	-5.439984	-0.153339	-4.643469	-1.9443	-2.782947
Beta Inflation	0.674332	0.763266	-1.019381	1.588069	-0.418151
Beta Oil Production	0.072779	-0.614885	0.553564	0.049372	0.04372
Beta Imports	1.98644	0.141577	1.788483	-0.106698	0.978442
Beta Exports	1.649085	0.808683	2.186706	3.488372	2.161943
Beta Exchange Rate	-1.0375361	-1.359109	-2.490907	-2.032758	-2.259853
Beta Gold Price	-0.091934	-0.161287	-0.342536	-0.255723	-0.188059

Sector	Material			
Company	ADC	AL BABTAIN	AMIANTIT	ASTRA INDUST
Constant	-0.465878	0.255325	-0.604129	-0.354305
Beta Treasury Bill	0.029466	0.126007	-0.009257	0.001668
Beta Unemployment	81.74554	-43.61945	110.1862	57.9612
Beta Money Supply	-0.174839	-0.209099	-0.503307	-0.492085
Beta Industrial Production	-0.008294	-0.052454	-0.263696	-0.361576
Beta GDP	-2.152454	-1.723807	-1.290187	-1.221355
Beta Inflation	0.181572	-1.456248	0.193445	1.248972
Beta Oil Production	-0.436603	0.592305	-0.537303	-0.270082
Beta Imports	0.502233	0.109195	0.279293	0.323828
Beta Exports	1.141726	3.206958	0.317325	0.623748
Beta Exchange Rate	-1.709386	-1.788403	-2.774962	-1.564123
Beta Gold Price	-0.028729	-0.373851	-0.209115	-0.28593

Sector	Material			
Company	MESC	SAUDI CERAMICS	SIECO	SVCP
Constant	-1.497626	-1.470088	0.84148	-0.133392
Beta Treasury Bill	-0.019253	-0.028663	-0.030434	0.070085
Beta Unemployment	261.6169	254.5084	-1.379692	19.3701
Beta Money Supply	-0.09316	-0.700467	-0.059293	-0.29205
Beta Industrial Production	-0.398625	-0.774968	0.723225	-0.104834
Beta GDP	-4.776325	-1.125628	-7.430631	2.641487
Beta Inflation	1.804471	2.389548	-0.878467	-0.484279
Beta Oil Production	-0.762318	-0.026144	-1.917198	-0.036879
Beta Imports	1.23352	0.279585	2.471012	-0.949454
Beta Exports	0.130795	0.359326	1.135235	1.557216
Beta Exchange Rate	-1.52294	-0.437456	-3.105177	1.35237

Beta Gold Price	-0.144879	-0.234368	0.241113	-0.197687

Sector	Transportation			
Company	BATIC	BUDGET SAUDI	SAPTCO	SISCO
Constant	0.804785	-0.240931	-0.136608	-0.599174
Beta Treasury Bill	-0.116542	0.018037	0.015484	-0.027687
Beta Unemployment	-139.055	51.9289	36.10719	104.2675
Beta Money Supply	0.023638	-1.023743	0.068596	-0.176237
Beta Industrial Production	1.19824	-0.271707	-0.079089	-0.311339
Beta GDP	3.340858	-3.239146	-5.749912	-0.465324
Beta Inflation	0.116583	-0.50499	-1.009539	1.452575
Beta Oil Production	-0.719325	0.288818	0.404948	-0.495423
Beta Imports	-1.746578	1.079837	2.537555	-0.63132
Beta Exports	-2.915629	1.754975	2.327562	-0.466812
Beta Exchange Rate	-1.350951	-1.806013	-1.806013	-3.059862
Beta Gold Price	-0.430192	-0.216261	-0.15859	-0.141338

Sector	Consumer Durables		
Company	ALABDULLATIF	FITAIHI	SIDC
Constant	0.185836	-0.829544	-0.373996
Beta Treasury Bill	-0.055124	0.015838	0.051945
Beta Unemployment	-13.48496	142.8367	78.8417
Beta Money Supply	-0.484503	0.295397	-0.494679
Beta Industrial Production	-0.098763	-0.179462	0.066074
Beta GDP	-7.202822	-3.286747	-4.736947
Beta Inflation	-1.333324	1.101006	-1.820732
Beta Oil Production	0.261134	-0.209734	-0.676872
Beta Imports	2.823919	0.635716	2.027557
Beta Exports	1.944692	0.9885	3.13198
Beta Exchange Rate	-1.935378	-1.762258	-2.507343
Beta Gold Price	-0.379095	-0.038033	0.241393

Sector	Consumer Services		
Company	ALKHALEEJ TRNG	DUR	TECO
Constant	-1.451055	-0.3412488	0.294084
Beta Treasury Bill	-0.013996	-0.020608	-0.031766
Beta Unemployment	271.6506	65.47689	-52.29687
Beta Money Supply	-0.95752	-0.024274	1.055304
Beta Industrial Production	-0.438295	-0.086035	0.115797

Beta GDP	-3.447649	-2.497958	-7.01787
Beta Inflation	-0.690931	0.0964983	1.043501
Beta Oil Production	-0.144103	-0.080963	-0.633115
Beta Imports	1.630074	0.82615	2.289719
Beta Exports	2.139612	0.588029	0.681314
Beta Exchange Rate	-0.76667	-1.355757	-1.380693
Beta Gold Price	-0.062663	-0.10393	-0.37444

Sector	Retail		
Company	ALHOKAIR	JARIR	SASCO
Constant	-0.554858	-0.740578	-0.212412
Beta Treasury Bill	-0.09339	-0.041764	-0.085792
Beta Unemployment	129.6176	142.5568	60.48027
Beta Money Supply	-1.439969	-0.51482	0.263417
Beta Industrial Production	-0.455714	-0.295511	0.047146
Beta GDP	-10.81142	-2.937716	-5.116792
Beta Inflation	-0.987393	-0.136548	-1.412722
Beta Oil Production	0.542882	0.146946	-0.02662
Beta Imports	4.813304	1.310397	2.205788
Beta Exports	2.82428	1.057701	0.394914
Beta Exchange Rate	-0.755563	0.365081	-1.692144
Beta Gold Price	-0.199697	-0.075578	0.063843

Sector	Food and Staples		
Company	ANAAM	OTHAIM	THIMAR
Constant	-1.074436	-0.957284	-1.947465
Beta Treasury Bill	-0.038469	0.060814	-0.012819
Beta Unemployment	197.7042	169.4461	357.8589
Beta Money Supply	1.116773	-0.021447	0.517579
Beta Industrial Production	-0.272004	-0.541872	-0.719048
Beta GDP	0.155625	0.727492	-4.761902
Beta Inflation	-0.307935	0.102527	0.042706
Beta Oil Production	-0.674795	0.228864	-0.69468
Beta Imports	0.120203	-0.017802	1.870876
Beta Exports	0.073528	1.381771	0.957281
Beta Exchange Rate	-1.88685	0.752339	-3.455793
Beta Gold Price	-0.23369	-0.156355	-0.558855

Sector	Food and Beverages				
Company	ALJOUF	ALMARAI	FOOD PRODUCTSCO	GACO	HB
Constant	-0.663978	-0.335273	-1.325614	-1.722631	-0.512707
Beta Treasury Bill	-0.014527	-0.012071	0.038595	-0.030896	-0.04651
Beta Unemployment	116.2738	61.65745	240.404	299.9351	108.4134
Beta Money Supply	0.579986	-0.312541	-0.629725	-0.196849	0.06267
Beta Industrial Production	-0.294189	-0.278919	-0.235408	-0.080003	-0.108942
Beta GDP	-1.729041	0.112899	-4.328106	3.625346	-5.055396
Beta Inflation	1.14253	0.542338	-0.00016	13372579	-1.024818
Beta Oil Production	-0.238999	0.178033	-0.991003	-0.345637	0.564932
Beta Imports	0.516692	-0.225145	1.477294	-1.932212	2.150225
Beta Exports	0.053782	-0.208197	1.994773	-0.384583	0.9091
Beta Exchange Rate	-1.058461	-0.163941	-2.881055	-2.682823	-1.086543
Beta Gold Price	-0.235913	-0.059482	-0.333704	-0.528049	-0.012846

Sector	Food and Beverages						
Company	JAZADCO	NADEC	SADAFCO	SAVOLA	SFICO	SHARQIYA	TADCO
Constant	-1.551861	-0.853245	-0.763529	-0.31994	-1.314079	-2.105108	-0.862661
Beta Treasury Bill	-0.032362	0.004035	0.036969	-0.05293	-0.011184	-0.113533	0.030758
Beta Unemployment	287.4085	156.9264	127.0731	76.37538	232.8879	372.4873	151.9867
Beta Money Supply	-0.041514	-0.500618	-0.0628175	-0.52562	-0.54099	0.515266	0.286061
Beta Industrial Production	-0.330639	-0.106776	-0.461403	-0.511476	-0.322502	-0.410401	-0.088627
Beta GDP	1.014184	-1.120432	0.254935	-6.24756	-2.314913	-2.627784	-3.036146
Beta Inflation	-0.840452	-0.388822	1.862255	-0.661268	1.028916	2.810945	0.215897
Beta Oil Production	-0.445315	-0.06041	-0.781179	-0.268105	-1.258701	-1.317208	-0.255022
Beta Imports	-0.0308484	0.154673	-0.825627	2.705307	1.033232	0.638034	1.160167
Beta Exports	0.455887	0.642192	0.715103	1.631682	0.682228	-1.419918	1.254433
Beta Exchange Rate	-1.501912	-0.95563	-829726	-0.762827	-1.374669	-0.505615	-1.814536
Beta Gold Price	-0.183036	-0.261936	-0.16102	-0.041339	-0.441166	-0.362776	-0.229733

Sector	Banks					
Company	AL RAJHI	ALAWWAL BANK	ALBILAD	ALINMA	AL JAZIRA	ARNB
Constant	0.035393	-0.234811	-0.806428	-0.346563	-0.126485	-0.392745
Beta Treasury Bill	0.05529	0.033084	0.005478	0.036722	-0.008113	-0.002528
Beta Unemployment	-10.79234	59.39241	148.1235	69.40083	38.86533	85.53235
Beta Money Supply	-0.592865	-0.437305	-0.942232	-0.609261	-0.418348	-0.177557
Beta Industrial Production	-0.139701	-0.178978	-0.308818	-0.157075	-0.10218	-0.27465
Beta GDP	-0.443886	-5.987247	-6.29449	-4.535658	-7.601226	-4.217671
Beta Inflation	0.207811	-2.090215	0.728313	-0.801897	-1.184877	-1.542633

Beta Oil Production	-0.053764	0.262977	-0.5871	-0.020165	-0.091552	0.212203
Beta Imports	-0.045209	2.8558	2.321016	1.828184	3.373912	1.994543
Beta Exports	0.879195	2.744977	1.524868	1.946771	2.25097	1.598239
Beta Exchange Rate	-0.668501	-0.517627	-0.950389	-0.938295	-2.143879	-0.925725
Beta Gold Price	-0.012965	-0.20684	-0.108885	-0.034255	-0.111295	0.004952

Sector	Banks				
Company	BSFR	RIYAD BANK	SABB	SAIB	SAMBA BANK
Constant	-0.586251	-0.826966	-0.699387	0.235495	-0.059255
Beta Treasury Bill	0.007727	0.004457	-0.023231	0.011839	0.006935
Beta Unemployment	114.8436	148.8638	142.8706	-21.396	16.29355
Beta Money Supply	-0.367987	-0.080219	-0.31608	0.071371	-0.3433333
Beta Industrial Production	-0.35725	-0.5057742	-0.328885	-0.112982	-0.233431
Beta GDP	-3.096083	1.705813	-5.090357	-6.929337	-0.193506
Beta Inflation	-0.804761	0.070618	-1.360737	-2.262374	-0.56175
Beta Oil Production	-0.2443759	-0.168853	-0.103272	0.191077	-0.240751
Beta Imports	1.358109	-0.543748	2.642214	3.357226	0.024687
Beta Exports	1.457068	0.194668	1.316846	2.543018	0.516663
Beta Exchange Rate	-1.112431	-1.084131	-0.976272	-1.572796	-0.828424
Beta Gold Price	-0.033364	-0.073867	-0.018543	-0.187208	0.037302

Sector	Financials		
Company	ASEER	KINGDOM	SAIC
Constant	-0.782073	1.75165	-0.944057
Beta Treasury Bill	-0.015974	0.095716	0.001651
Beta Unemployment	151.1197	-293.7903	173.1352
Beta Money Supply	-0.573955	0.242077	-0.234064
Beta Industrial Production	-0.276419	0.460332	-0.305345
Beta GDP	-2.319989	-0.952555	-0.974155
Beta Inflation	-0.666116	-4.414963	-0.104967
Beta Oil Production	-0.593507	-0.438811	-0.511377
Beta Imports	0.718059	1.473809	0.211858
Beta Exports	1.280816	3.943526	0.843216
Beta Exchange Rate	-1.894166	-0.751997	-2.384187
Beta Gold Price	-0.103503	-0.332676	-0.030266

Sector	Telecom			Utilities	
Company	ETIHAD	STC	ZAIN	SAUDI ELECTRIC	GASCO
Constant	0.516292	0.019689	-1.248948	-0.159	-1.029726
Beta Treasury Bill	-0.037595	0.004373	0.091417	0.054486	0.038496
Beta Unemployment	-91.3085	3.051642	203.7103	30.84564	191.8498
Beta Money Supply	0.543078	-0.618912	-0.672209	-0.668991	-1.160303
Beta Industrial Production	-0.113492	0.05375	-0.425271	-0.154246	-0.39758
Beta GDP	-3.891436	0.174539	-0.217766	0.789184	-6.599428
Beta Inflation	0.730108	-0.779464	1.695187	-0.577562	-0.215792
Beta Oil Production	0.00063	-0.372994	-0.46234	-0.459557	-0.316668
Beta Imports	2.127211	-0.061378	-0.418567	-0.241452	2.649911
Beta Exports	0.305021	0.06254	1.162534	0.688032	1.701363
Beta Exchange Rate	-0.450252	-0.859824	-1.243115	-1.624243	-0.977603
Beta Gold Price	-0.062352	-0.105294	-0.336794	-0.134507	-0.039092

Sector	Real Estate			
Company	ARDCO	DAR ALARKAN	EMAAR EC	JABAL OMAR
Constant	-0.78058	-0.207487	-0.455948	-0.083231
Beta Treasury Bill	-0.000271	0.145138	0.126295	0.060727
Beta Unemployment	131.7566	26.52726	78.02385	26.59219
Beta Money Supply	-0.129534	-0.170023	-0.859583	-1.589494
Beta Industrial Production	-0.107669	-0.181793	0.155672	-0.200075
Beta GDP	2.611634	-3.617404	-2.612879	-6.632782
Beta Inflation	1.303159	-0.142063	-0.429034	-0.86673
Beta Oil Production	-0.434596	0.28615	-0.184205	-0.132329
Beta Imports	-1.170692	0.975161	0.598654	2.369155
Beta Exports	-0.704579	-0.704579	2.470915	2.624823
Beta Exchange Rate	-1.15706	-1.321687	-1.62928	-0.871184
Beta Gold Price	-0.12916	-0.375901	-0.218563	-0.083308

Sector	Real Estate			
Company	MCDC	RED SEA	SERCO	TAIBA
Constant	-0.099898	-0.896952	-0.477203	-0.019162
Beta Treasury Bill	0.052634	0.103884	0.013803	-0.002881
Beta Unemployment	18.60191	163.1333	88.30996	16.40344
Beta Money Supply	-0.488875	-0.276538	-0.633908	-0.024256
Beta Industrial Production	-0.09101	-0.50216	-0.275711	-0.010033
Beta GDP	-0.529108	-4.172734	-5.826432	-5.100405
Beta Inflation	-0.256978	-0.784073	0.568341	-0.995875

Beta Oil Production	0.247197	-0.752158	-0.628706	0.415022
Beta Imports	0.049042	1.768702	2.033765	2.231606
Beta Exports	1.511741	2.571646	1.228438	1.290404
Beta Exchange Rate	-0.749193	-2.523822	-1.956721	-1.441314
Beta Gold Price	-0.485375	-0.144421	-0.17838	-0.093842

Sector	Insurance					
Company	ACIG	AICC	AL AHLIA	ALLIANZ	ARABIAN SHIELD	ATC
Constant	2.191172	-0.058449	0.331295	-1.068091	0.326467	-0.545491
Beta Treasury Bill	0.045302	0.104128	-0.041723	-0.154396	-0.049538	-0.014121
Beta Unemployment	-361.4746	-3.507929	-54.43508	200.7626	-49.13826	102.8909
Beta Money Supply	-0.016134	-0.170667	1.23302	-0.077844	-0.198025	-0.772892
Beta Industrial Production	1.046916	0.200006	-0.115485	0.127727	0.296753	0.229868
Beta GDP	-15.32534	-3.35337	-1.103667	-2.133752	-1.532518	0.051703
Beta Inflation	-4.481549	0.68737	-0.270466	1.040806	-0.320995	-0.678958
Beta Oil Production	-0.663982	-0.763898	-0.719291	-1.015038	-0.618748	-1.600677
Beta Imports	6.273496	0.637016	0.299668	0.353443	0.357092	-0.277546
Beta Exports	4.437361	2.300389	-0.13299	-2.158876	-0.863214	0.36839
Beta Exchange Rate	-1.531669	-2.514095	-3.440285	-2.125919	-2.854109	-0.924466
Beta Gold Price	0.50626	-0.233997	-0.07038	-0.040876	0.152436	0.157777

Sector	Insurance					
Company	BUPA ARABIA	GULF UNION	MALATH	MEDGULF	SAAB TAKAFUL	SAGR INSURANCE
Constant	-1.35588	0.09548	-0.710179	-1.823149	-1.068091	-0.503675
Beta Treasury Bill	0.053263	0.007128	-0.002122	0.030542	-0.54396	-0.004346
Beta Unemployment	261.3904	-17.61753	136.7764	331.9354	200.7626	92.60447
Beta Money Supply	-0.792489	-0.65931	-1.072617	-1.316933	-0.07784	0.24012
Beta Industrial Production	-0.485177	0.087477	-0.071224	-0.91796	0.127727	0.041292
Beta GDP	-0.816228	-2.511701	-5.272219	-8.392379	-2.133752	2.038305
Beta Inflation	-1.975692	0.336771	-0.875775	0.877083	1.040806	-0.512944
Beta Oil Production	-1.153945	-1.197029	-0.792066	-1.154306	-1.015038	-0.839588
Beta Imports	-0.010219	0.52415	1.761978	3.318373	0.353443	-1.286416
Beta Exports	1.94877	0.784239	2.838808	2.691775	-2.158876	-1.074807
Beta Exchange Rate	-2.188716	-2.719422	-1.386797	-1.17235	-2.125919	-1.368138
Beta Gold Price	-0.242821	-0.24318	-0.058733	-0.368814	-0.040876	0.172936

Sector	Insurance					
Company	SAICO	SALAMA	SAUDI RE	TAWUNIYA	TRADE UNION	UCA
Constant	-0.004079	0.324175	-0.37863	-0.794496	-0.960395	-0.503675
Beta Treasury Bill	-0.110432	-0.002126	0.01519	0.154072	0.005153	-0.004346

Beta Unemployment	2.74775	-55.52387	66.22737	121.653	183.5069	92.60447
Beta Money Supply	0.48505	-0.340056	0.279361	-0.235359	0.201022	0.24012
Beta Industrial Production	0.179211	0.421192	-0.02752	-0.677847	-0.275215	0.41292
Beta GDP	-3.540057	-5.736004	0.934157	7.373072	-4.304423	2.038305
Beta Inflation	1.529476	-0.067798	-0.196383	1.086268	-1.031849	-0.512944
Beta Oil Production	-0.423664	-1.10386	-0.5356	-0.875633	-1.287428	-0.839588
Beta Imports	0.606871	1.975667	-0.594183	-4.149442	-1.682616	-1.286416
Beta Exports	-1.860961	1.002711	0.691467	1.553115	1.882101	-1.074807
Beta Exchange Rate	-2.316932	-2.102464	-2.090256	-1.666557	-2.630649	-1.368138
Beta Gold Price	-0.100627	-0.242349	-0.093662	-0.509529	-0.0118573	0.172936

Sector	Insurance	
Company	WAFA	WALAA
Constant	0.68971	0.191823
Beta Treasury Bill	0.0186	0.053813
Beta Unemployment	-131.9916	-33.59544
Beta Money Supply	0.289073	0.467256
Beta Industrial Production	0.395756	0.265921
Beta GDP	-5.533944	-5.856498
Beta Inflation	1.43974	-0.290481
Beta Oil Production	-1.534402	-0.534753
Beta Imports	1.607157	2.293106
Beta Exports	0.477582	0.537278
Beta Exchange Rate	-3.801	-2.389253
Beta Gold Price	-0.264613	0.091235

Appendix B:

Expected Signs of the sector and macro variable:

	Sector	Factors	Positive or Negative Effect on Returns
Gunsel, Rjoub and Tursoy(2008)	Manufacturing of wood production including furniture	M2 CPI GOLD Exports Unemployment MPI	Positive Positive Positive Positive Positive Positive
	Manufacturing of paper and paper products, printing	Industrial Production Oil CPI GOLD IMP EXP GDP FOR EXCH UNEM MPI	Positive Positive Positive Positive Positive Positive Positive Positive Positive Positive Positive
	Manufacturing of non metallic mineral products	M2 GOLD Imports FOR Unemployment MPI	Positive Positive Positive Positive Positive Positive
	Manufacturing of food beverage and tobacco	M2 CPI GOLD IMP GDP FOR EXCH UNEM INTE	Positive Positive Positive Positive Positive Positive Positive Positive Positive

	Manufacturing of textile, wear and paper industry	M2 Industrial Production Oil CPI GOLD IMP EXP GDP EXCH UNEM MPI	Positive Positive Positive Positive Positive Positive Positive Positive Positive Positive Positive
	Manufacturing of chemical, petroleum, rubber and plastic	M2 INDUSTURIAL PRODUCTION OIL CPI GOLD FOR UMEPMPI	Positive Positive Positive Positive Positive Positive Positive Positive
	Manufacturing of basic metal industry	CPI GOLD Imports Exports Exchange Rate Unemployment MPI	Positive Positive Positive Positive Positive Positive Positive
	Manufacturing of fabrical metal products	Industrial Production Oil CPI GOLD IMP GDP FOR EXCH UNEM MPI	Positive Positive Positive Positive Positive Positive Positive Positive Positive Positive
	Other manufacturing industry	Industrial Production CPI FOR EXCH UNEMP	Positive Positive Positive Positive Positive

	Electric, gas and water	Industrial Production Oil Gold Imp Exp Exch INTE	Positive Positive Positive Positive Positive Positive Positive
	Transportation and communication	Industrial Production CPI GOLD IMP EXP UNEMP MPI	Positive Positive Positive Positive Positive Positive Positive
Gunsel, Rjoub and Tursoy (2009)	BANSFC	TERST UNIFIN RISKPR EXCGR MONSP UNEMP	Postive Positive Negative Positive
	ELEGAW	TERST UNIFIN RISKPR EXCGR MONSP UNEMP	Positive Positive Negative
	MANBMI	TERST UNIFIN RISKPR EXCGR MONSP UNEMP	Positive Positive Negative Positive Negative Positive
	MANCPR	TERST UNIFIN RISKPR EXCGR MONSP UNEMP	Positive Positive Positive Positive Positive
	MANFBT	TERST UNIFIN RISKPR EXCGR MONSP UNEMP	Positive Positive Positive Negative Positive

	MANFMP	TERST UNIFIN RISKPR EXCGR MONSP UNEMP	Positive Postive Negative
	MANNMP	TERST UNIFIN RISKPR EXCGR MONSP UNEMP	 Positive Positive Positive Positive
	MANOMI	TERST UNIFIN RISKPR EXCGR MONSP UNEMP	 Positive Positive Positive Negative Positive Positive
	MANPPP	TERST UNIFIN RISKPR EXCGR MONSP UNEMP	 Positive Positive Negative Positivev Positive
	MANTWP	TERST UNIFIN RISKPR EXCGR MONSP UNEMP	Positive Positive Negative
	MANWPF	TERST UNIFIN RISKPR EXCGR MONSP UNEMP	Negative Positive Positive Negative Positive Positive
	TRACOM	TERST UNIFIN RISKPR EXCGR MONSP UNEMP	 Positive Positive

	INSCOM	TERST UNIFIN RISKPR EXCGR MONSP UNEMP	Positive Positive Positive Positive Positive Positive
Tursoy and Awwad (2016)	LBNK	Interest Rate Money Supply Exchange Rate	Positive Positive Positive
	LIN	Interest Rate Money Supply Exchange Rate	Positive Positive Positive
	EX	Interest Rate Money Supply Exchange Rate	Positive Positive Positive
	LM2	Interest Rate Money Supply Exchange Rate	Positive Positive Positive
Azeez and Yonezawa	All industries - Prebubble	Money Supply CPI IPI Term Structure Exchange Rate Land Price	Positive Negative Negative Positive Positive Positive
	Manufacturing - Prebubble	Money Supply CPI IPI Term Structure Exchange Rate Land Price	Negative Positive Positive Negative Negative Negative
	All industries - Bubble Period	Money Supply CPI IPI Term Structure Exchange Rate Land Price	Positive Negative Negative Positive Positive Positive
	Manufacturing - Bubblle Period	Money Supply CPI IPI Term Structure Exchange Rate Land Price	Negative Positive Positive Negative Negative Negative

	All industries - Post Bubble	Money Supply CPI IPI Term Structure Exchange Rate Land Price	Positive Negative Negative Positive Positive Positive
	Manufacturing - Post Bubble	Money Supply CPI IPI Term Structure Exchange Rate Land Price	Negative Positive Positive Negative Negative Negative
Chen Hsieh (1985)	Portfolio 1	changes in expected inflation changing risk premium change in the yield curve unanticipated inflation market index the change in the growth rate of industrial production.	Positive Negative Negative Positive Positive Positive
	Portfolio 2	changes in expected inflation changing risk premium change in the yield curve unanticipated inflation market index the change in the growth rate of industrial production.	Positive Negative Negative Negative Positive Negative
	Portfolio 3	changes in expected inflation changing risk premium change in the yield curve unanticipated inflation market index the change in the growth rate of industrial production.	Positive Negative Negative Positive Positive Positive
	Portfolio 4	changes in expected inflation changing risk premium change in the yield curve unanticipated inflation market index the change in the growth rate of industrial production.	Positive Negative Negative Negative Positive Negative
	Portfolio 5	changes in expected inflation changing risk premium change in the yield curve unanticipated inflation market index the change in the growth rate of industrial production.	Positive Negative Negative Positive Positive Positive

	Portfolio 6	changes in expected inflation changing risk premium change in the yield curve unanticipated inflation market index the change in the growth rate of industrial production.	Positive Negative Negative Negative Positive Negative
	Portfolio 7	changes in expected inflation changing risk premium change in the yield curve unanticipated inflation market index the change in the growth rate of industrial production.	Positive Negative Negative Positive Positive Positive
	Portfolio 8	changes in expected inflation changing risk premium change in the yield curve unanticipated inflation market index the change in the growth rate of industrial production.	Positive Negative Negative Negative Positive Negative
	Portfolio 9	changes in expected inflation changing risk premium change in the yield curve unanticipated inflation market index the change in the growth rate of industrial production.	Positive Negative Negative Positive Positive Positive
	Portfolio 10	changes in expected inflation changing risk premium change in the yield curve unanticipated inflation market index the change in the growth rate of industrial production.	Positive Negative Negative Positive Positive Positive
	Portfolio 11	changes in expected inflation changing risk premium change in the yield curve unanticipated inflation market index the change in the growth rate of industrial production.	Positive Negative Negative Negative Positive Negative

	Portfolio 12	changes in expected inflation changing risk premium change in the yield curve unanticipated inflation market index the change in the growth rate of industrial production.	Positive Negative Negative Negative Positive Negative
	Portfolio 13	changes in expected inflation changing risk premium change in the yield curve unanticipated inflation market index the change in the growth rate of industrial production.	Positive Negative Negative Negative Positive Negative
	Portfolio 14	changes in expected inflation changing risk premium change in the yield curve unanticipated inflation market index the change in the growth rate of industrial production.	Positive Negative Negative Negative Positive Negative
	Portfolio 15	changes in expected inflation changing risk premium change in the yield curve unanticipated inflation market index the change in the growth rate of industrial production.	Positive Negative Negative Negative Positive Negative
	Portfolio 16	changes in expected inflation changing risk premium change in the yield curve unanticipated inflation market index the change in the growth rate of industrial production.	Positive Negative Negative Negative Positive Negative
	Portfolio 17	changes in expected inflation changing risk premium change in the yield curve unanticipated inflation market index the change in the growth rate of industrial production.	Positive Negative Negative Positive Positive Positive

	Portfolio 18	changes in expected inflation changing risk premium change in the yield curve unanticipated inflation market index the change in the growth rate of industrial production.	Positive Negative Negative Positive Positive Positive
	Portfolio 19	changes in expected inflation changing risk premium change in the yield curve unanticipated inflation market index the change in the growth rate of industrial production.	Positive Negative Negative Positive Positive Positive
	Portfolio 20	changes in expected inflation changing risk premium change in the yield curve unanticipated inflation market index the change in the growth rate of industrial production.	Positive Negative Negative Negative Positive Negative
Poon and taylor (1991)	Portfolio 1	annual industrial production index the unanticipated inflation risk premium term structure the returns on a value weighted market index the returns on an equally weighted market index.	Positive Negative Negative Positive Positive Positive
	Portfolio 2	annual industrial production index the unanticipated inflation risk premium term structure the returns on a value weighted market index the returns on an equally weighted market index.	Positive Negative Negative Positive Positive Positive
	Portfolio 3	annual industrial production index the unanticipated inflation risk premium term structure the returns on a value weighted market index the returns on an equally	Positive Negative Negative Positive Positive Positive

		weighted market index.	
	Portfolio 4	annual industrial production index the unanticipated inflation risk premium term structure the returns on a value weighted market index the returns on an equally weighted market index.	Positive Negative Negative Positive Positive Positive
	Portfolio 5	annual industrial production index the unanticipated inflation risk premium term structure the returns on a value weighted market index the returns on an equally weighted market index.	Positive Negative Negative Positive Positive Positive
	Portfolio 6	annual industrial production index the unanticipated inflation risk premium term structure the returns on a value weighted market index the returns on an equally weighted market index.	Positive Negative Negative Positive Positive Positive
	Portfolio 7	annual industrial production index the unanticipated inflation risk premium term structure the returns on a value weighted market index the returns on an equally weighted market index.	Negative Negative Negative Positive Positive Negative

	Portfolio 8	annual industrial production index the unanticipated inflation risk premium term structure the returns on a value weighted market index the returns on an equally weighted market index.	Positive Negative Negative Positive Positive Positive
	Portfolio 9	annual industrial production index the unanticipated inflation risk premium term structure the returns on a value weighted market index the returns on an equally weighted market index.	Positive Negative Positive Positive Positive Negative
	Portfolio 10	annual industrial production index the unanticipated inflation risk premium term structure the returns on a value weighted market index the returns on an equally weighted market index.	Positive Negative Positive Positive Positive Negative
	Portfolio 11	annual industrial production index the unanticipated inflation risk premium term structure the returns on a value weighted market index the returns on an equally weighted market index.	Positive Negative Negative Positive Positive Positive
	Portfolio 12	annual industrial production index the unanticipated inflation risk premium term structure the returns on a value weighted market index the returns on an equally weighted market index.	Positive Negative Negative Positive Positive Positive

	Portfolio 13	annual industrial production index the unanticipated inflation risk premium term structure the returns on a value weighted market index the returns on an equally weighted market index.	Positive Negative Negative Positive Positive Positive
	Portfolio 14	annual industrial production index the unanticipated inflation risk premium term structure the returns on a value weighted market index the returns on an equally weighted market index.	Negative Negative Negative Positive Positive Negative
	Portfolio 15	annual industrial production index the unanticipated inflation risk premium term structure the returns on a value weighted market index the returns on an equally weighted market index.	Positive Negative Positive Positive Positive Negative
	Portfolio 16	annual industrial production index the unanticipated inflation risk premium term structure the returns on a value weighted market index the returns on an equally weighted market index.	Negative Negative Negative Positive Positive Negative
	Portfolio 17	annual industrial production index the unanticipated inflation risk premium term structure the returns on a value weighted market index the returns on an equally weighted market index.	Positive Negative Positive Positive Positive Negative

	Portfolio 18	annual industrial production index the unanticipated inflation risk premium term structure the returns on a value weighted market index the returns on an equally weighted market index.	Positive Negative Positive Positive Positive Negative
	Portfolio 19	annual industrial production index the unanticipated inflation risk premium term structure the returns on a value weighted market index the returns on an equally weighted market index.	Positive Negative Positive Positive Positive Negative
	Portfolio 20	annual industrial production index the unanticipated inflation risk premium term structure the returns on a value weighted market index the returns on an equally weighted market index.	Positive Negative Positive Positive Positive Negative
Dhrymes, Friend and Gultekin (1984)	Group 1	Factor 1 Factor 2 Factor 3 Factor 4 Factor 5 Factor 6 Factor 7 Factor 8 Factor 9 Factor 10	Positive Negative Positive Positive Negative Negative Positive Positive Positive Negative

	Group 2	Factor 1	Positive
		Factor 2	Negative
		Factor 3	Positive
		Factor 4	Positive
		Factor 5	Negative
		Factor 6	Negative
		Factor 7	Positive
		Factor 8	Positive
		Factor 9	Positive
		Factor 10	Negative
	Group 3	Factor 1	Positive
		Factor 2	Positive
		Factor 3	Negative
		Factor 4	Negative
		Factor 5	Negative
		Factor 6	Positive
		Factor 7	Positive
		Factor 8	Positive
		Factor 9	Positive
		Factor 10	Negative
	Group 4	Factor 1	Positive
		Factor 2	Negative
		Factor 3	Positive
		Factor 4	Positive
		Factor 5	Negative
		Factor 6	Negative
		Factor 7	Positive
		Factor 8	Positive
		Factor 9	Positive
		Factor 10	Negative
	Group 5	Factor 1	Positive
		Factor 2	Positive
		Factor 3	Negative
		Factor 4	Negative
		Factor 5	Negative
		Factor 6	Positive
		Factor 7	Positive
		Factor 8	Positive
		Factor 9	Positive
		Factor 10	Negative

	Group 6	Factor 1 Factor 2 Factor 3 Factor 4 Factor 5 Factor 6 Factor 7 Factor 8 Factor 9 Factor 10	Positive Negative Positive Positive Negative Negative Positive Positive Positive Negative
	Group 7	Factor 1 Factor 2 Factor 3 Factor 4 Factor 5 Factor 6 Factor 7 Factor 8 Factor 9 Factor 10	Positive Negative Positive Positive Negative Negative Positive Positive Positive Negative
	Group 8	Factor 1 Factor 2 Factor 3 Factor 4 Factor 5 Factor 6 Factor 7 Factor 8 Factor 9 Factor 10	Positive Positive Negative Negative Negative Positive Positive Positive Positive Negative
	Group 9	Factor 1 Factor 2 Factor 3 Factor 4 Factor 5 Factor 6 Factor 7 Factor 8 Factor 9 Factor 10	Positive Positive Negative Negative Negative Positive Positive Positive Positive Negative

	Group 10	Factor 1 Factor 2 Factor 3 Factor 4 Factor 5 Factor 6 Factor 7 Factor 8 Factor 9 Factor 10	Positive Negative Positive Positive Negative Negative Positive Positive Positive Negative
	Group 11	Factor 1 Factor 2 Factor 3 Factor 4 Factor 5 Factor 6 Factor 7 Factor 8 Factor 9 Factor 10	Positive Positive Negative Negative Negative Positive Positive Positive Positive Negative
	Group 12	Factor 1 Factor 2 Factor 3 Factor 4 Factor 5 Factor 6 Factor 7 Factor 8 Factor 9 Factor 10	Positive Positive Negative Negative Negative Positive Positive Positive Positive Negative
	Group 13	Factor 1 Factor 2 Factor 3 Factor 4 Factor 5 Factor 6 Factor 7 Factor 8 Factor 9 Factor 10	Positive Negative Positive Positive Negative Negative Positive Positive Positive Negative

	Group 14	Factor 1 Factor 2 Factor 3 Factor 4 Factor 5 Factor 6 Factor 7 Factor 8 Factor 9 Factor 10	Positive Positive Negative Negative Negative Positive Positive Positive Positive Negative
	Group 15	Factor 1 Factor 2 Factor 3 Factor 4 Factor 5 Factor 6 Factor 7 Factor 8 Factor 9 Factor 10	Positive Positive Negative Negative Negative Positive Positive Positive Positive Negative
	Group 16	Factor 1 Factor 2 Factor 3 Factor 4 Factor 5 Factor 6 Factor 7 Factor 8 Factor 9 Factor 10	Positive Positive Negative Negative Negative Positive Positive Positive Positive Negative
	Group 17	Factor 1 Factor 2 Factor 3 Factor 4 Factor 5 Factor 6 Factor 7 Factor 8 Factor 9 Factor 10	Positive Positive Negative Negative Negative Positive Positive Positive Positive Negative

	Group 18	Factor 1 Factor 2 Factor 3 Factor 4 Factor 5 Factor 6 Factor 7 Factor 8 Factor 9 Factor 10	Positive Positive Negative Negative Negative Positive Positive Positive Positive Negative
	Group 19	Factor 1 Factor 2 Factor 3 Factor 4 Factor 5 Factor 6 Factor 7 Factor 8 Factor 9 Factor 10	Positive Positive Negative Negative Negative Positive Positive Positive Positive Negative
	Group 20	Factor 1 Factor 2 Factor 3 Factor 4 Factor 5 Factor 6 Factor 7 Factor 8 Factor 9 Factor 10	Positive Negative Positive Positive Negative Negative Positive Positive Positive Negative
	Group 21	Factor 1 Factor 2 Factor 3 Factor 4 Factor 5 Factor 6 Factor 7 Factor 8 Factor 9 Factor 10	Positive Positive Negative Negative Negative Positive Positive Positive Positive Negative

	Group 22	Factor 1 Factor 2 Factor 3 Factor 4 Factor 5 Factor 6 Factor 7 Factor 8 Factor 9 Factor 10	Positive Negative Positive Positive Negative Negative Positive Positive Positive Negative
	Group 23	Factor 1 Factor 2 Factor 3 Factor 4 Factor 5 Factor 6 Factor 7 Factor 8 Factor 9 Factor 10	Positive Positive Negative Negative Negative Positive Positive Positive Positive Negative
	Group 24	Factor 1 Factor 2 Factor 3 Factor 4 Factor 5 Factor 6 Factor 7 Factor 8 Factor 9 Factor 10	Positive Positive Negative Negative Negative Positive Positive Positive Positive Negative
	Group 25	Factor 1 Factor 2 Factor 3 Factor 4 Factor 5 Factor 6 Factor 7 Factor 8 Factor 9 Factor 10	Positive Positive Negative Negative Negative Positive Positive Positive Positive Negative

	Group 26	Factor 1 Factor 2 Factor 3 Factor 4 Factor 5 Factor 6 Factor 7 Factor 8 Factor 9 Factor 10	Positive Negative Positive Positive Negative Negative Positive Positive Positive Negative
	Group 27	Factor 1 Factor 2 Factor 3 Factor 4 Factor 5 Factor 6 Factor 7 Factor 8 Factor 9 Factor 10	Positive Positive Negative Negative Negative Positive Positive Positive Positive Negative
	Group 28	Factor 1 Factor 2 Factor 3 Factor 4 Factor 5 Factor 6 Factor 7 Factor 8 Factor 9 Factor 10	Positive Negative Positive Positive Negative Negative Positive Positive Positive Negative
	Group 29	Factor 1 Factor 2 Factor 3 Factor 4 Factor 5 Factor 6 Factor 7 Factor 8 Factor 9 Factor 10	Positive Positive Negative Negative Negative Positive Positive Positive Positive Negative

	Group 30	Factor 1 Factor 2 Factor 3 Factor 4 Factor 5 Factor 6 Factor 7 Factor 8 Factor 9 Factor 10	Positive Positive Negative Negative Negative Positive Positive Positive Positive Negative
	Group 31	Factor 1 Factor 2 Factor 3 Factor 4 Factor 5 Factor 6 Factor 7 Factor 8 Factor 9 Factor 10	Positive Positive Negative Negative Negative Positive Positive Positive Positive Negative
	Group 32	Factor 1 Factor 2 Factor 3 Factor 4 Factor 5 Factor 6 Factor 7 Factor 8 Factor 9 Factor 10	Positive Negative Positive Positive Negative Negative Positive Positive Positive Negative
	Group 33	Factor 1 Factor 2 Factor 3 Factor 4 Factor 5 Factor 6 Factor 7 Factor 8 Factor 9 Factor 10	Positive Negative Positive Positive Negative Negative Positive Positive Positive Negative

	Group 34	Factor 1 Factor 2 Factor 3 Factor 4 Factor 5 Factor 6 Factor 7 Factor 8 Factor 9 Factor 10	Positive Negative Positive Positive Negative Negative Positive Positive Positive Negative
	Group 35	Factor 1 Factor 2 Factor 3 Factor 4 Factor 5 Factor 6 Factor 7 Factor 8 Factor 9 Factor 10	Positive Negative Positive Positive Negative Negative Positive Positive Positive Negative
	Group 36	Factor 1 Factor 2 Factor 3 Factor 4 Factor 5 Factor 6 Factor 7 Factor 8 Factor 9 Factor 10	Positive Negative Positive Positive Negative Negative Positive Positive Positive Negative
	Group 37	Factor 1 Factor 2 Factor 3 Factor 4 Factor 5 Factor 6 Factor 7 Factor 8 Factor 9 Factor 10	Positive Positive Negative Negative Negative Positive Positive Positive Positive Negative

	Group 38	Factor 1 Factor 2 Factor 3 Factor 4 Factor 5 Factor 6 Factor 7 Factor 8 Factor 9 Factor 10	Positive Positive Negative Negative Negative Positive Positive Positive Positive Negative
	Group 39	Factor 1 Factor 2 Factor 3 Factor 4 Factor 5 Factor 6 Factor 7 Factor 8 Factor 9 Factor 10	Positive Positive Negative Negative Negative Positive Positive Positive Positive Negative
	Group 40	Factor 1 Factor 2 Factor 3 Factor 4 Factor 5 Factor 6 Factor 7 Factor 8 Factor 9 Factor 10	Positive Positive Negative Negative Negative Positive Positive Positive Positive Negative
	Group 41	Factor 1 Factor 2 Factor 3 Factor 4 Factor 5 Factor 6 Factor 7 Factor 8 Factor 9 Factor 10	Positive Negative Positive Positive Negative Negative Positive Positive Positive Negative

	Group 42	Factor 1	Positive
		Factor 2	Negative
		Factor 3	Positive
		Factor 4	Positive
		Factor 5	Negative
		Factor 6	Negative
		Factor 7	Positive
		Factor 8	Positive
		Factor 9	Positive
		Factor 10	Negative