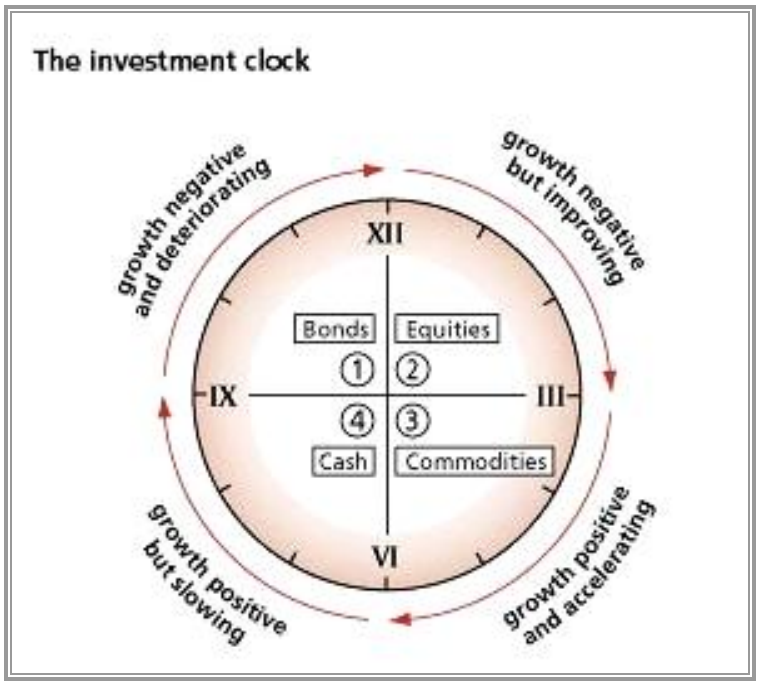
UNIVERSITY OF PIRAEUS
DEPARTMENT OF BANKING AND FINANCE
POSTGRADUATE PROGRAM

THESIS:
REAL TIME INVESTMENT STRATEGIES



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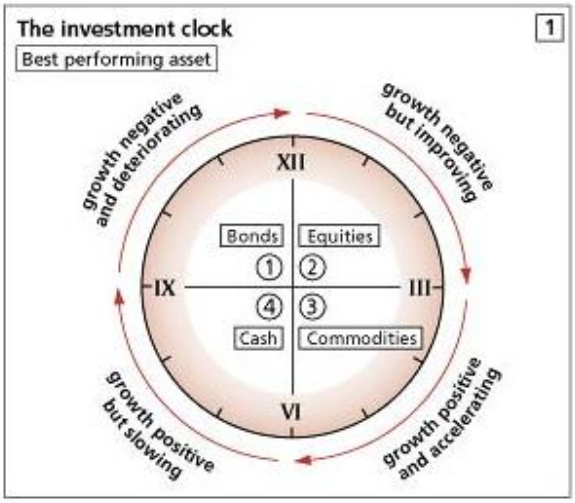
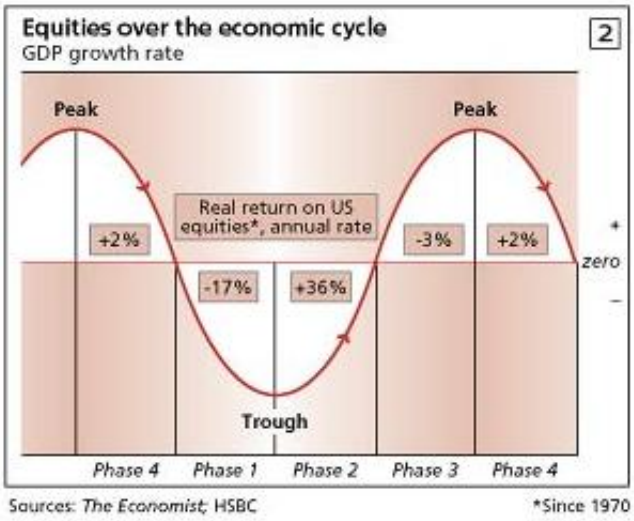
1. INTRODUCTION

Successful investment management has always been a challenging task. In 2001, America's Federal Reserve has proceeded to eleven successive interest rate cuts, bringing the rate to 1.75%, its lowest point since 1961. Investors all over the world watched their deposits returns shrink and started to realize that making safe and easy money was becoming a very difficult task. In Greece, after the European convergence and the entrance in the euro-zone, we experience for the first time such low interest rates, a fact that makes the need for active investment management even more imperative. So, the analysis and selection of investment vehicles looks more attractive than ever.

The idea for this thesis came from an article in the April 21st 2001 issue of the Economist magazine, titled "Waiting for the midnight hour". In this article, the writer presents the economic cycle like an investment clock and breaks this investment clock into four quarters, the first representing negative growth but improving, the second positive growth and accelerating, the third positive growth but slowing and the fourth negative growth and deteriorating. He then, argues that at each phase of the cycle one of the four assets he examines -bonds, equities, commodities and cash- tends to outperform the others.

Briefly, the article claims that bond prices usually beat other assets when growth is negative and deteriorating, and interest rates fall in order to fight recession. Share prices surge when the economy has bottomed and monetary policy has become laxer. As the economy strengthens and inflation rises, commodities and property fare best. Finally, as central banks raise interest rates to fight inflation, cash is a good shelter. This pattern is crudely presented in the form of an investment clock, in the first diagram below. The investment clock does not provide any information about the size of future asset-price movements, it just helps understanding their timing. In the same article a more detailed analysis of stock behavior over the economic cycle is made, which is depicted in the second diagram below and will be presented in the second chapter.





The analysis made in the article mentioned above, was based on ex-post revised data, while when market participants made their decisions they were based on the real time preliminary data available at that particular time. Data revisions can bring significant changes, modifying the definitions of variables and incorporating new source data. We will refer to data revisions more analytically in the third chapter.

In this thesis, we will first verify the results of the above article and we will then repeat the analysis, working exclusively with real time data for the United States. Finally, we will make the same analysis for the rest of the G-7 countries, working with ex-post revised data, for the lack of appropriate unrevised data.

We next proceed to a detailed analysis of each one of the four investment vehicles.

2. INVESTMENT VEHICLES

2.1 BONDS

2.1.1 Introduction

The first investment vehicle we are going to analyze is bonds. Bonds constitute the main category of fixed income securities. A bond is a debt security representing a contractual agreement, by which the issuer promises to the holder to pay the principal by a specified future date and a series of periodic interest payments up to the repayment date.

The main features of bonds are the type of the issuer, the maturity of the issue and the bond's coupon rate. The main issuers of debt are corporations, municipal governments and federal governments and its agencies. There are many differences concerning yield, denomination, safety of principal, maturity, tax status and provisions among the various types of issuers.

A bond's term-to-maturity, the number of years during which the issuer has undertaken the obligation to meet the conditions of the debt, is important because it determines the yield on a bond and even the volatility of a bond's price. Further there are different kinds of risk related to the maturity of a bond. If we attempt a primary classification we can divide bonds to three classes: short-term bonds, with a maturity of 1 to 5 years, intermediate-term bonds, with a maturity between 5 and 12 years and long-term bonds, with a maturity greater than 12 years. We note here that when considering a bond's maturity, the investor should pay attention to any provisions that modify the maturity of a bond, such as call, put and sinking fund provisions.

A bond's coupon is the periodic interest payment made to the bondholder during the life of the bond. Most of the times, in the United States the coupon payment is made every six months, while for bonds issued in some European bond markets and all bonds issued in the Eurobond market, the coupon payment is made once a year. Nevertheless, there is an important class of bonds, called zero-coupon bonds, which do not make periodic interest payments, but instead the investor receives interest by buying the bond at a price below its face value and holding it to the maturity date, when he is paid the face value. In contrast to bonds with fixed coupon rates, there are

floating-rate securities (floaters) whose coupon rate is reset at fixed dates, according to the value of some reference rate adjusted for a spread. The level of the coupon on any bond is typically close to the level of yields for issues of its class when the bond is first sold to the public. Furthermore, issuers try to set the coupon at a level that will make the market price close to par value. This goal can be accomplished by placing the coupon rate near the prevailing market rate. The coupon rate, apart from its main function of determining the interest received from the investor, plays another major role. It influences the volatility of the bond's price. The larger the coupon, the less the price will change in response to changes in market interest rates.

2.1.2 Risks of bond investment

We refer next to the different types of risk, which faces a bondholder due to future uncertainty:

- *Market or interest-rate risk:* it is the risk that faces an investor who may have to trade a bond before the maturity date and it is due to changes in interest-rates. It is the biggest risk the bondholder is exposed to. Nevertheless this sort of risk is of no concern to the investor who plans to hold the bond to maturity.
- *Reinvestment risk:* it is the risk that the periodic coupon payments may have to be reinvested at lower market rates. Reinvestment risk is greater for longer periods and for bonds with large, early cash flows such as high-coupon bonds. It should be noted that interest-rate risk and reinvestment risk oppose each other.
- *Credit or default risk:* it is the risk that the promised cash flows from the issuer of the bond may not be paid in full. Most bonds in the United States are sold at a lower price than comparable Treasury bonds, which are considered free of default risk. Indeed, the investor is concerned more with the change in the perceived risk and the spread demanded from the market for a particular bond than with the actual event of default.
- *Exchange rate risk:* it is the risk that exchange rate changes may affect the cash flows of a bond denominated in a foreign currency.
- *Yield-curve or maturity risk:* when a bond of a given maturity is considered as an alternative to another bond of a different maturity, an assumption is usually made about how the interest rates at different maturities will move. More precisely a

parallel shift assumption is made concerning the yield curve. The risk that the yield movements may not be consistent to the assumption made is called yield-curve risk.

- *Inflation risk:* it is the risk that the future cash flows received from a bond may have less value in terms of purchasing power because of inflation.
- *Liquidity risk:* it is the risk that the bondholder may have to sell a bond below its true value, where the true value is indicated by a recent transaction. The main measure of liquidity is the spread between the bid price and the ask price quoted by a dealer. The wider the spread the greater the liquidity risk.
- *Volatility risk:* it is the risk that a change in volatility will negatively affect the price of a bond. It is an important sort of risk for bonds with embedded options, where changes in volatility have a great impact in the value of the option.
- *Call risk:* It is the risk that a bond with a call provision may be called by the issuer, leaving the investor exposed mainly to reinvestment risk.
- *Political or legal risk:* it is the risk that political or legal actions may adversely affect the value of a bond.
- *Event risk:* it is the risk that a particular event such as an industrial accident or a corporate restructuring may reduce the value of a bond.
- *Sector risk:* it is the risk of adverse differential movement of specific sectors of the market.

2.1.3 Bond pricing

The price of any bond is equal to the present value of the expected cash flow. The expected cash flow of a bond consists of the periodic coupon interest payments to the maturity date and the face value at maturity. In other words it consists of an annuity and the face or maturity value. The discount rate used to compute the present value of a bond, which is called the required yield, is determined by observing the yields offered on comparable bonds in the market. The price of a bond can be calculated from the following formula:

$$P = \frac{C}{R}\left[1 - \frac{1}{(1+R)^n}\right] + \frac{M}{(1+R)^n}$$

where

P = price of the bond

C = coupon payment (annual)

n = number of periods to maturity

R = required yield

M = maturity or face value

When a bond is issued, the coupon rate and term-to-maturity are fixed. So, as yields in the market change the only factor that can be adjusted to reflect this change is the price of the bond. For example, consider a bond traded at par. When yields in the market rise above the coupon rate, the price of the bond falls below par. This price difference is a capital gain and represents a form of interest to the investor to compensate for the coupon rate being lower than the required yield.

Possible reasons for a change in a bond's price are:

- A change in the level of interest rates.
- Simply, the movement of the bond toward maturity without any change in the required yield, when dealing with a bond selling at a price other than par.
- A change in the required yield due to changes in the spread to Treasuries.
- A change in the perceived credit quality of the issuer.
- For bonds with embedded options, a change in the factors that affect the value of the embedded options.

We next state some very important properties concerning the sensitivity of bond prices:

- The price of a bond changes in the direction opposite to the change in the required yield. However, this relationship is not linear and the shape of the price/yield relationship is convex.
- For a given required yield change, the bond's sensitivity increases with maturity, but at a decreasing rate.

- For a relatively large change in basis points in the required yield, the percentage price increase is greater than the percentage price decrease, while for small changes in the required yield it is roughly the same.

- Bonds with same maturity and face value, but higher coupon have lower sensitivity.
- The higher the level of interest rates the lower the price sensitivity.

The most usual cause for a change in a bond's price is a change in the level of interest rates in the economy. Two different approaches are presented in the literature concerning the measurement of interest rate risk exposure.

Under the first approach, which is called the full valuation approach, we have simply to revalue the price of the bond for a specific interest rate change, using the classical bond valuation formula presented above. It is a very accurate approach and should be used when we deal with a portfolio of few bonds, but it is time consuming when a large number of complex bonds must be revalued, which is most of the time the case.

The second approach is the duration approach. Duration is the average life of a bond or more technically, the weighted-average time to maturity, using the relative present values of the bond's cash flows as weights. Duration is a very meaningful concept because it takes into account the time of arrival of all cash flows as well as the bond's maturity. The duration can be computed with the following formula:

$$D = \frac{\sum_{t=1}^{N} CF_t \times DF_t \times t}{\sum_{t=1}^{N} CF_t \times DF_t} = \frac{\sum_{t=1}^{N} PV_t \times t}{\sum_{t=1}^{N} PV_t}$$

where

D = duration measured in years

CF_t = cash flow received on the bond at end of period t

N = last period in which the cash flow is received

DF_t = discount factor = $1/(1 + R)^t$, where R is the current market interest rate

PV_t = present value of the cash flow at the end of period t

Duration, apart from measuring the average life of a bond, has in addition an economic meaning as the interest sensitivity of a bond's value. In fact, it is the

$$\frac{dP}{} = -D\left(\frac{dR}{}\right)$$

approximate percentage change in value for a 100 basis point change in rates. This can be easily derived from the following formula:

So, duration determines approximately the percentage price change of the bond's value, dP/P, for any given change in interest rates, dR/1+R. We say approximately because the relationship between the price of a bond and a change in interest rates is, as already mentioned, convex and not linear. Duration is a very important tool in the effort for hedging and immunization against interest rate risk.

2.1.4 Return measures

Concerning yield assessment two conventional measures are common in the literature:

- Current yield = Annual coupon / Price. It is a return measure of very limited importance as it takes into account only the coupon interest and ignores any other source of return, such as income from reinvestment of the coupon payments or capital gain/loss from the future performance of the bond.
- Yield to maturity. It is the interest rate that will make the present value of the cash flows equal to the price of the bond. In other words, it is the internal rate of return earned from holding a bond to maturity. This return measure depends on two assumptions that limit its correctness. The investor will realize the yield to maturity stated at the time of purchase only if the coupon payments can be reinvested at the yield to maturity and if the bond is held to maturity.

A specific case of this return measure is the spot rate. Spot rates are the yields to maturity on zero coupon bonds, bonds that offer to the investor only one cash flow, when the bond matures. Spot rates play a very important role in bond valuation. In fact when computing a bond's price we have to discount the cash flow of every future period with the corresponding spot rate of this period. For example if we price a coupon bond that matures in two years we have to discount the first year's cash flow with the spot rate of the one year zero coupon bond (of the same credit quality) and the second year's cash flow with the spot rate of the two-year zero coupon bond.

For the purposes of this thesis we will work with a more complete return measure, which performs much better the task of assessing a bond's return. It is called

$$(1+R_{t+1}) = \frac{P_{t+1} + C_{t+1}}{}$$

holding period return, or total return and it gives the return on a bond over some holding period less than its maturity. The holding period return can be calculated from the formula:

where R_{t+1} is the one-period holding-period return on a bond purchased at time t and sold at time t+1, P_{t+1} is the price of the bond when it is sold and C_{t+1} is the coupon interest payment received at time t+1.

2.1.5 Bond indexes

In our analysis we are going to work with total return bond indexes, that is, bond indexes which include interest payments as well as capital gains or losses. Bond indexes play a major role in measuring performance, first because they provide an accurate benchmark of bond market behavior and second, because it has been proved that, most bond portfolio managers have not managed to outperform them. Bond portfolio managers have two main alternatives: active management driven mainly by expectations of interest rate changes and passive management, which involves most of the times the creation and maintenance of a portfolio that tracks the performance of a given bond index. During the first half of 1986 and the second half of 1998 active bond managers underperformed the passive indexes in two of the most volatile bond markets in the past fifty years. Since index portfolios have lower management fees and lower transaction costs they usually outperform the average active portfolio. Furthermore bond indexes facilitate the analysis of the risk/return characteristics of the bond market, as well as the documentation of intertemporal changes that affect these characteristics.

Bond indexes are divided into three main categories: a) U.S. investment grade bonds, b) U.S. high-yield bonds and c) international government bonds. There are some important issues related to the construction of a bond index of either category. The first and most important is the sample of securities, including number of bonds, maturity and size of issue. The second issue is whether the returns are market-value weighted or equally weighted. Market-value weighting reflects the economic importance of the issue, but it involves a more complicated computation because the possibility of calls, sinking funds and redemptions must be taken into account. On the other hand, equal weighting depends on the assumption of the random selection of

issues and it involves an easier computation. The third issue is the quality of the price data used. It is not always possible to take prices from actual market transactions because many bonds are negotiated in a less liquid market, where traders give their best estimate of the price. Finally, the last issue is the reinvestment rate used for intermediate cash flows. Indexes treat intermediate cash flows differently. It may be assumed that interim cash flows are immediately reinvested in the bonds that generated the cash flows, or that they are reinvested at the one-month T-bill rate, or that they are not reinvested at all. Immediate reinvestment in the same bond is the most aggressive assumption, while no reinvestment the most conservative one.

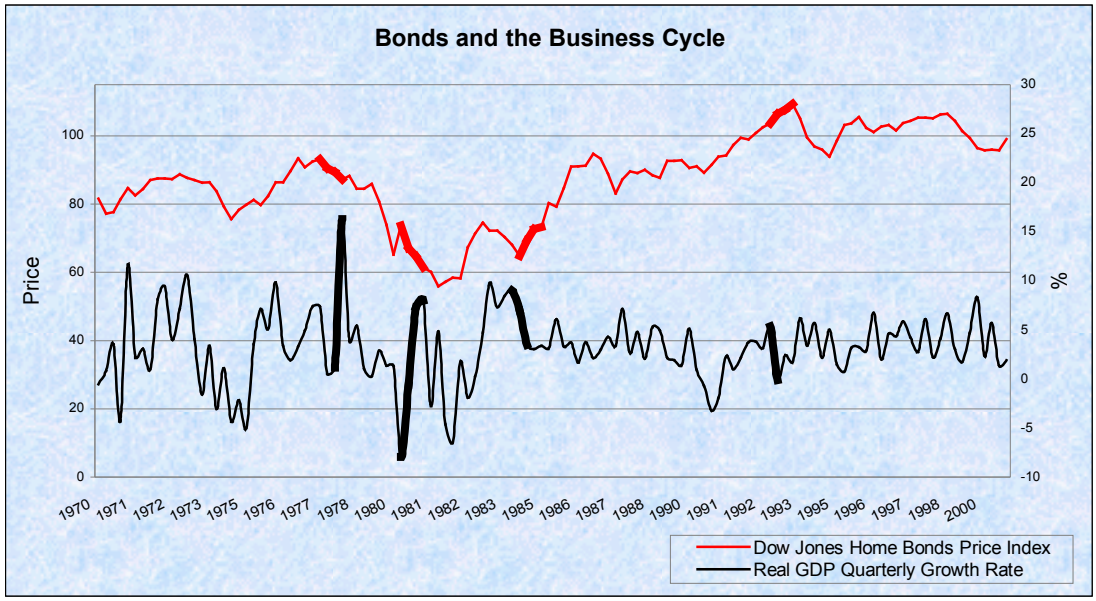
We have to note here that there are some details that make the construction of a bond index far more complicated and difficult than that of a stock market index. The main difference is that the population of bonds is broader, ranging from Treasury issues to municipal bonds and from A rated bonds to default bonds, while stock indexes are more homogenous. Another point is that the population of bonds changes constantly, due to specific features of each bond issue. Further, the volatility of bond prices varies across issues and over time, due to the duration and convexity of the bond. Finally, there can be significant problems in the pricing of individual bond issues, while stock issues, generally are more liquid.

2.1.6 Bonds performance over the business cycle

According to the Economist article, bonds are the appropriate investment vehicle just before interest rates begin to fall, at least a year before the trough of the economic cycle. Market participants buy bonds at this period because they expect that the central bank will lower interest rates in order to fight recession. When the economy strengthens, interest rates start rising again. We are in the phase of negative but improving growth and bond prices fall.

In the diagram below we have taken Dow Jones Home Bonds Index and quarterly growth rate of United States real GDP, in order to have a first picture of how bonds perform over the business cycle. We have marked some parts of the diagram where the inverse relation between growth rate and bond prices can be seen. We observe that bond prices generally rise both when growth is negative and deteriorating and when growth is positive but slowing. We hope that after our analysis is completed

we will be in a position to tell at which phase bonds perform best and whether they outperform at any phase the other investment vehicles.



Source: Thomson Financial DataStream

2.2 EQUITIES

2.2.1 Introduction

Equities or shares or stocks are the second investment vehicle we are interested in. When a company wishes to raise capital, it has two basic options. The first one is to borrow, either directly from a financial institution or by issuing bonds, which we analytically presented in the previous section. The second option is to sell shares to investors. A share is a security that represents ownership in a corporation and confers certain rights on the holder. Holders of common stock exercise control by electing a board of directors and voting on corporate policy. Common shares are considered a risky security because common stockholders are on the bottom of the priority ladder for ownership structure. In the event of liquidation common shareholders have rights to a company's assets only after bondholders, preferred shareholders and other debt holders have been paid in full. On the other hand common shareholders have the expectation of higher yields as a compensation for the undertaking of greater risk.

2.2.2 Equities pricing and return

The payoff to investors who buy stocks comes from dividends and capital gains or losses. Dividends are simply the percentage of a company's profits that directors decide to give back to shareholders. Traditionally, established companies return a higher percentage of earnings to shareholders, while companies in a growth phase often limit dividend payments so they can reinvest their earnings in further growth.

The price of a stock must equal the value of the future dividends, expected during the holding period, plus the future sale price expected to be received at the end

of the holding period, all discounted at a discount rate that commensurate with the risk associated with the particular stock. In a well-functioning capital market all securities in an equivalent risk class are priced to offer the same expected return. So, the price of a stock is computed with the following formula:

$$P_0 = E_t \sum_{t=1}^{H} \frac{D_t}{(1+R)^t} + \frac{P_H}{(1+R)^H}$$

where P_0 is the stock price, D_t is the dividend per stock to be received at each period from 1 to H, P_H is the forecasted price at the end of the investment horizon and R is the investors required rate of return. As can be easily seen from this formula forecasting future dividends and the future price at the end of the investment horizon is necessary in order to compute the stock price. This task apart from being hard is also subjective.

For the purposes of this thesis, we fortunately need only to compute ex-post returns from holding a stock for a particular period. The return for the period of interest is given from the following formula:

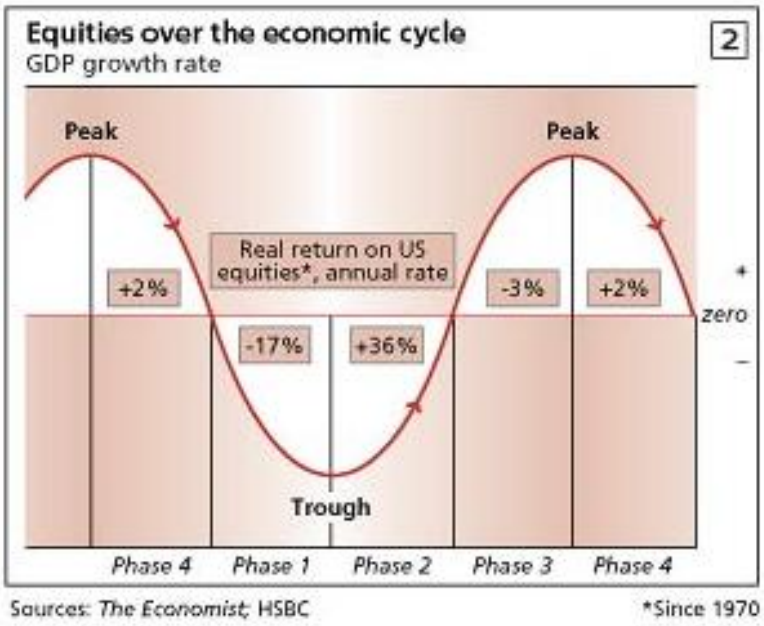
$$\left(1 + R_{t+1}\right) = \frac{P_{t+1} + D_{t+1}}{P_t}$$

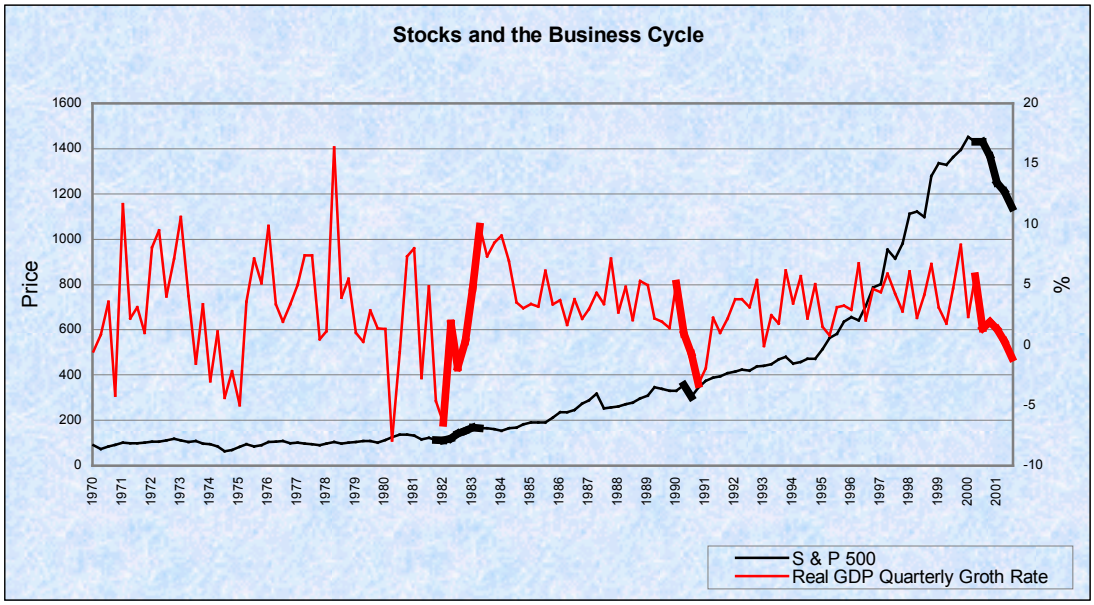
where R_{t+1} is the one-period return on a stock purchased at time t and sold at time t+1, P_{t+1} is the price of the stock when it is sold and D_{t+1} is the dividend received at time t+1.

2.2.3 Equities performance over the business cycle

According to the Economist article, shares are the best choice just before the trough of the economic cycle, when monetary policy has become laxer. This is the right choice for the investor who thinks that the rate of decline of GDP has bottomed out. After all, the main characteristic of stock markets is that of discounting the future. The darkest hour is just before dawn.

Equities behavior is presented with great detail in the Economist article, which refers to an analysis of Peter Oppenheimer, global strategist at HSBC. Mr. Oppenheimer purports that over the past 30 years, US stocks have always fallen in phase one, as the economy slumped, but in phase two when the contraction of the economy is less steep, shares have surged, with an average real gain of 36% at an annual rate. Phase two is relatively brief, lasting on average only six months and the initial rally accounted for as much as half of the total stock market gain in the first three years of a bull market. In phase three, stocks offered a 3% real loss, while at phase four they offered a 2% real gain.





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In the above diagram we have taken S & P 500 Index and quarterly growth rate of United States real GDP, in order to have a first picture of how stocks perform over the business cycle. We observe that stocks generally rise fast when GDP growth rate jumps and fall sharply when GDP growth rate takes a clear downward trend. We have marked some parts of the diagram, which show this behavior. Nevertheless, due to the prolonged period of high growth rates from 1991 to 2000 stocks cycles are not so obvious. We hope that after our analysis is completed we will be in a position to tell at which phase stocks perform best and whether they outperform at any phase the other investment vehicles.

2.2.4 Cyclical stocks

For the purposes of this thesis we will mainly work with cyclical stocks because they are very indicative of the business cycle. In fact these stocks tend to be

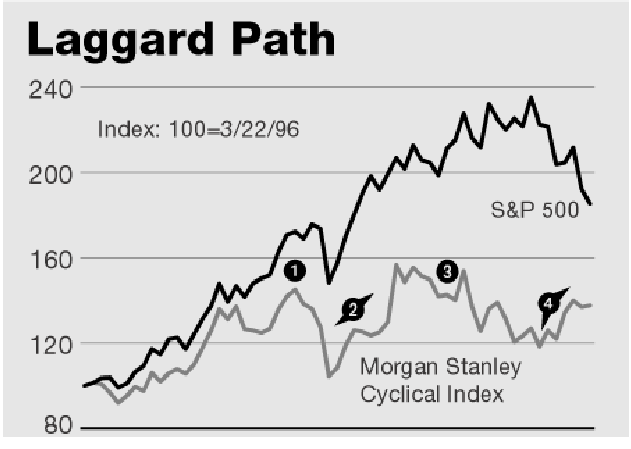
more sensitive to the health of the economy. Their earnings fluctuate with the business cycle's various stages. Cyclical stocks are characterised by flexible demand. On the other hand, defensive stocks, in industries such as utilities, drugs, health care and food, are often more resilient in recessions and stock market slides because product demand is more stable. The difference between a cyclical and non-cyclical stock is tied closely to consumer need and demand. The business cycle, along with cyclical stocks, involves interest, inflation, and unemployment rates. If these factors increase, businesses will do poorly and have lower profits. In contrast, a decrease in these factors will cause businesses to boom and have very strong earnings.

2.2.5 Stock indexes

For the purposes of our analysis we will work with stock indexes. A stock index reflects the general behavior of the market, acting as a benchmark for all market participants. As with bond indexes, the construction of a stock index requests the treatment of some basic issues. First of all, the sample of stocks participating in the index must be chosen, so as to be as representative of the market as possible. Second, a decision concerning equal weighting or market-value weighting must be taken and finally how is the index going to treat splits, dividends and other facts that affect the price of the participating stocks must be defined.

Concerning the selection of stock indexes we are going to use, cyclical stock indexes will be preferred because they tend to closely follow the business cycle. For countries where such indexes are not available we will chose indexes which are mainly formed from cyclical stocks.

In order to understand the importance of the use of a cyclical stock index instead of a broader one, let's consider the Morgan Stanley cyclical index, which is made up of 30 economically sensitive stocks in 25 industries. Its members range from



heavy-equipment maker Caterpillar to copper producer Phelps Dodge and to newspaper publisher Knight Ridder. As the chart presented below shows, over the longer periods of time, the broader S&P 500 has outperformed it by a substantial margin. In fact, from June 1996 to March 2001, the cyclical index climbed 37%, while the broader S&P 500 gained 85% and the big-tech Nasdaq 100 rocketed 186%. This doesn't mean that cyclical stocks don't lead the market at certain times, but instead that their rallies tend to be short-lived. That's what happened in 1999. Large global companies, many of the firms in the cyclical index, found themselves vulnerable to the Asian financial crisis that swept the world markets (point 1 in the graph). When the storm lifted in late 1998 and early 1999, they rallied (point 2). But their leadership lasted only for four months until tech stocks moved to the forefront later in 1999 and 2000, bringing cyclical stocks to the bottom of investors' shopping lists (point 3). Finally, the cyclical index rallied from October to March, rising 27% due to expectations for a stronger economy (point 4).

2.3 COMMODITIES

2.3.1 Introduction

Commodities are the third investment vehicle we present. Commodities are physical goods, which have the following characteristics that make it feasible to trade them in markets:

- They can be stored for long periods.
- Their value depends heavily on measurable physical features and on the physical location of the commodities.
- Commodities with the same physical features and the same physical location are equivalent and perfect substitutes. If a buyer has contracted to purchase wheat of a certain type, he should not be concerned about which farmer raised the wheat.

Commodities markets set prices for commodities, offering to producers the opportunity to trade them for other goods. Most participants in the commodities markets are producers, users and intermediaries firms, operating between them.

Investors instead of investing directly in commodities generally prefer to invest in futures contracts, because it is less costly to purchase futures contracts than purchase and store the commodities themselves. Alternatively they can invest in commodity indexes.

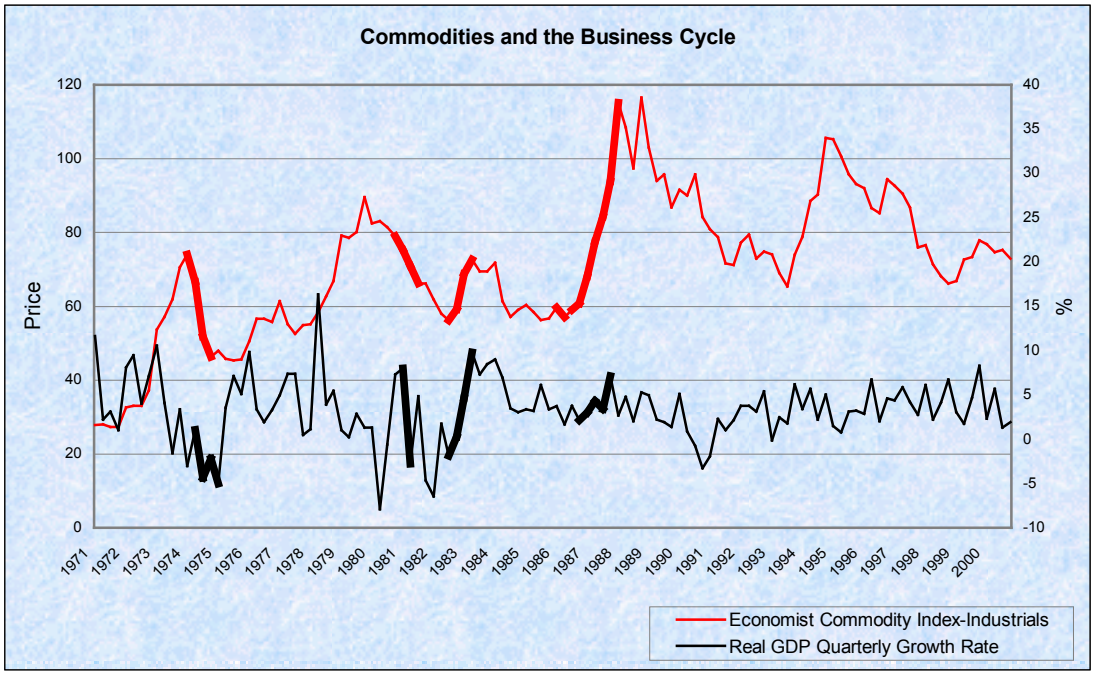
2.3.2 Commodities indexes

We will work with commodity indexes in order to better monitor the investment performance of commodities. From the variety of commodity indexes we will prefer those consisted of industrial commodities and we will exclude those comprising energy commodities or food commodities because the latter are heavily affected from facts besides the business cycle, such as weather conditions and supply shocks.

2.3.3 Commodities performance over the business cycle

According to the Economist article, commodities are the best performing investment vehicle, as the expansion nears its peak and inflation rises. At this phase of the cycle, a wealth effect dominates the economy and drives commodities price up.

In the following diagram we have taken the Economist Commodity Index, which consists of only industrial commodities and the growth rate of United States real GDP, in order to have a first picture of how commodities perform over the business cycle. We observe that when growth is positive and accelerating commodities perform quite well, while their worst performance seems to occur when growth rate has taken a clear downward trend. We have marked some parts of the diagram in order to show these trends. We expect our analysis to shed more light to commodities behaviour over the business cycle.



Source: Thomson Financial DataStream

2.4 MONEY MARKET INSTRUMENTS

2.4.1. Introduction

The term money market refers to the network of corporations, financial institutions, investors and governments, which deal with the flow of short-term capital. Money market can be defined as the market for debt instruments maturing in one year or less. Similar to bond investors, money market investors are extending credit, without taking any ownership in the borrowing entity or any control over management. Money markets attach a price to liquidity, the availability of money for immediate investment. Furthermore, the interest rates for short-term funds serve as

benchmarks for longer-term financial instruments. For this reason money market is very closely related to the bond market. The main types of money market instruments are the following:

- *Treasury bills:* these are securities with maturity of one year or less, issued by national governments. Treasury bills issued by a government in its own currency act as a very strong benchmark, because they are generally considered the safest of all possible investments in that currency.
- *Commercial paper:* it is a short-term, usually unsecured debt obligation of a corporation. In most cases, the paper has maturity greater than 90 days but less than nine months. The commercial paper market has become hugely popular during the last 20 years because strong firms discovered that they could raise capital more cheaply by selling commercial paper to money market funds than by borrowing from banks. On the other side money market funds enabled investors to earn higher rates than bank could offer.
- *Certificate of deposit:* it is a certificate indicating that a specified sum of money has been deposited at the issuing depository institution. The certificate of deposit bears a maturity date and a specific interest rate. This type of instrument is the most traditional instrument investors use, it is a simple deposit of money.
- *Repurchase agreement (repos):* it is the sale of a security with a commitment by the seller to buy the security back from the purchaser at a specified price and at a particular future date. The difference between the repurchase price and the sale price is the interest cost of the loan. Repos play a major role in the money markets, because they offer high liquidity and ensure that there will be a constant supply of buyers for new money market instruments. Investors like repos because of their flexibility. The average maturity of a repo is only a few days, but it is possible to arrange one for any desired term. In a repurchase agreement any type of security can be used, although in practice the vast majority of repos involve national government notes.

2.4.2 Money market instruments performance over the business cycle

According to the Economist article cash is king when growth is at its peak and starts slowing. This has a logical explanation: when growth rate is at its peak, central bank raises interest rates to fight inflation. As interest rates rise, bond prices naturally fall. Increased interest rates make business financing more costly and negatively affect investment and growth, bringing the threat of lower future earnings. In the same time investors require higher returns from stocks as risk-free rate has increased. So, increased interest rates generally depress share prices. Commodities prices also, fall due to weakest demand and lower consumer confidence. So, cash seems to be a shelter at this phase of the cycle.

3. DATA REVISIONS

When an analysis is made the first important decision that has to be taken is which data are going to be used. In the Economist article the analysis was based on ex post revised data for the United States. Revised data are widely used because it is easier to find them in a database. On the other hand, producing a real time data set is much more difficult because the researcher has to find out exactly what data were

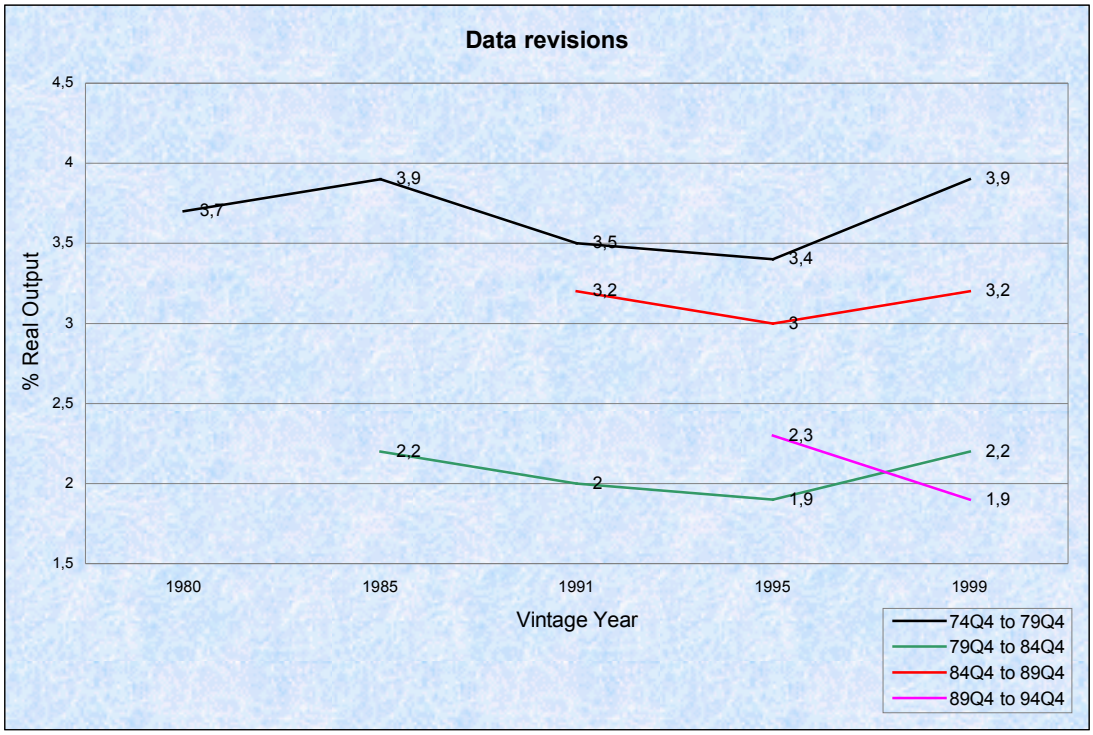
available to economic agents and at what time. Data revisions can have a significant impact to the observed accounts, modifying the definitions of variables and incorporating new source data. The base year was changed for real variables in January 1976 (from 1958 to 1972), in December 1985 (from 1972 to 1982), in November 1991 (from 1982 to 1987) and in January 1996 (from 1987 to 1992).

In order to see how data revisions can affect our variables we present in the following table how the growth rate of real output changes as the vintage date changes. Vintage is the information set available at a particular date. Each table entry shows the average annual growth rate of the real output over the five-year period, as recorded in each vintage year.

Period	Vintage year				
Real output	1980	1985	1991	1995	1999
74Q4 to 79Q4	3,7	3,9	3,5	3,4	3,9
79Q4 to 84Q4		2,2	2	1,9	2,2
84Q4 to 89Q4			3,2	3	3,2
89Q4 to 94Q4				2,3	1,9

Source: A real-time data set for macroeconomists (Dean Croushore, Tom Stark), Research Department, Federal Reserve Bank of Philadelphia

We observe significant changes in moving from the 1985 to 1991 vintage year and from the 1995 to the 1999 vintage year. These changes show clearly that data revisions have an important impact on the growth rate of real output. This can be also seen in the following diagram.


Data revisions
4,5
4
3,5
3
2,5
2
1,5
% Real Output
3,7
3,9
3,5
3,4
3,9
3,2
3
3,2
2,2
2
1,9
2,2
2,3
1,9
1980
1985
1991
1995
1999
Vintage Year
74Q4 to 79Q4
79Q4 to 84Q4
84Q4 to 89Q4
89Q4 to 94Q4

4. PROPOSAL

In order to find out if the investment strategy proposed in the Economist article is right we will make the following steps. We will start with investing 100 dollars in the year 1970 in the vehicle that is expected to perform best, according to the phase of the business cycle of the economy. Next, as the economy moves we will invest both the proceeds and the initial capital in the appropriate vehicle according to the business cycle analysis of the Economist article. For example, a year before the trough, when growth is negative and deteriorating, we will invest in a bond index, because according to our analysis, bonds start to outperform other assets at that particular time. We will make the appropriate investment at each phase of the business cycle. We will then compute Sharpe ratios for the total period investment and compare with the Sharpe ratio of each particular investment vehicle, supposing it was held during the whole period 1970-2001.

We will complete the above procedure both with revised and real time data for the United States and with revised data for the other countries of the G7.

5. METHODOLOGY

In this chapter we present in detail every part of the research performed. Our work consists of the following three analyses: a) an analysis based on ex post revised data of GDP growth rate for each of the G-7 countries, b) an analysis based on ex post revised data of industrial production for the United States and c) an analysis based on real-time preliminary data of GDP growth rate for the United States. Each analysis includes the following stages:

Stage 1: Phases identification

Stage 2: Computation and comparison of cumulative returns

Stage 3: Computation and comparison of Sharpe ratios

Stage 4: Sensitivity analysis (not performed in the third analysis)

5.1 Ex post analysis (GDP based)

Stage 1: Phases identification

This is the main analysis we performed and was executed for each of the G-7 countries. The first stage of this analysis was to split the economic cycle into the four investment phases, presented in Economist's article, with a sound manner. We identified each phase of the cycle with the aid of a smoothing performed using the four quarters moving average of GDP growth rate. In order to make clear how we made the identification of the phases we present United States case:

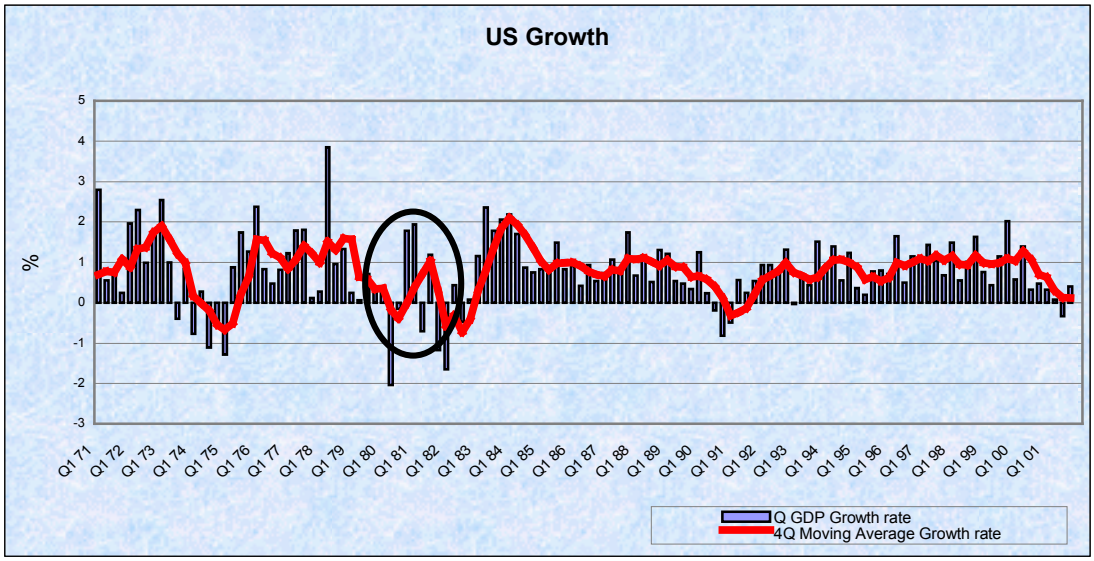
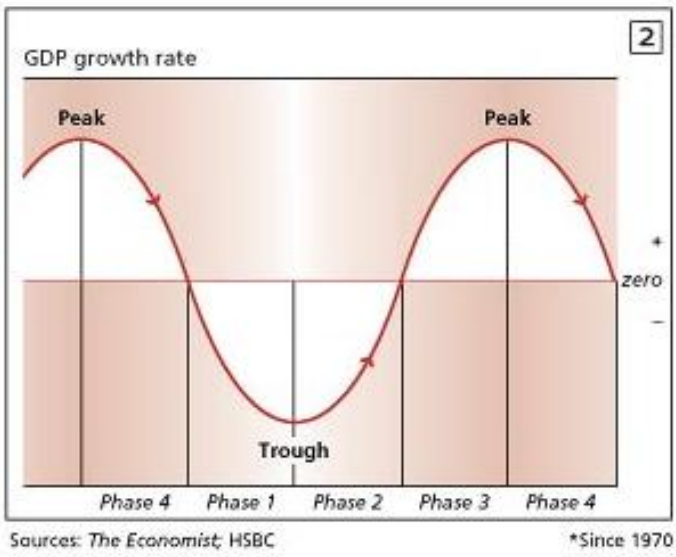


Diagram 1

In the diagram above the bar chart depicts quarterly GDP growth rate, while the red line shows the four quarters moving average of GDP growth rate. We identify the phases of the cycle following the movement of the four quarters moving average. We remind how the four phases are defined in the following familiar scheme:



So, when the four quarters moving average of growth rate crosses the X-axis downwards, showing growth negative and deteriorating, we enter in phase one. When the four quarters moving average has bottomed out, showing growth negative but improving we enter in phase two. When it crosses the X-axis upwards, showing growth positive and accelerating we enter in phase three. Finally when the moving average has reached a peak, showing growth positive but slowing we enter in phase four. Let's take a precise example from United States diagram (marked with a black

cycle). In the second quarter of 1980 the four quarters moving average of United States growth rate crosses the X-axis downwards so we enter in the first phase of a new cycle. In the next quarter it reaches a trough entering in the second phase of the cycle, while in the following quarter crosses the X-axis upwards entering in the third phase of this cycle. Finally, in the third quarter of 1981 it reaches a peak, entering in the fourth and last phase of this cycle. In the fourth quarter of 1981 it crosses the X-axis downwards again and a new cycle begins. We have to note here that it is very common to observe phase three and four succeed each other several times before a cycle ends. For example, returning in the United States example, in the fourth quarter of 1992 we enter in the fourth phase of a specific cycle. In the third quarter of 1993 we see that growth, which is still positive, stops slowing and accelerates again returning us again in the third phase of the cycle. In the third quarter of 1994, growth reenters phase four. A next cycle does not start unless a new phase one makes its appearance.

Since the identification of the phases is completed we have just to invest in the appropriate investment vehicle following the Economist's investment clock. So, each time we are in phase one we invest in bonds, in phase two in equities, in phase three in commodities and in phase four in the money market. Our investment in a specific vehicle starts at the first month of the quarter that signals the beginning of the respective phase. If, for example, in the second quarter of 1980 we enter in phase one of a cycle, we invest in bonds in the first of April of 1980.

Stage 2: Computation and comparison of cumulative returns

Our next step was to construct the four series, one for every investment vehicle we used. Since we have constructed the data series and we have identified the phases of the cycle we can proceed to the main part of our analysis. That part starts with computing the monthly returns of the strategy and of each investment vehicle, for the period of interest. With the returns in hand we will be then able to compute Sharpe ratios for our strategy and compare with the Sharpe ratios of each investment vehicle. We present next a snapshot of United States case in order to show clearly how we perform this vital part of our analysis. Let's look into the following table:

Period	Bond index		Equity index		Comm. index		Interest rates		Investm. Strategy	
	Price	Return	Price	Return	Price	Return	Rates	1M return	Inv. vehicle	Return
1/4/1980	33,76		84,95		84,4		13,2	0,0110	**Bonds**	
1/5/1980	38,32	0,1350	83,69	-0,0148	80,7	-0,0438	8,58	0,0072	»	**0,1350**

1/6/1980	39,07	0,0196	87,53	0,0459	82	0,0161	7,07	0,0059	»	**0,0196**
1/7/1980	40,33	0,0321	91,01	0,0398	81,8	-0,0024	8,06	0,0067	**Equities**	**0,0321**
1/8/1980	38,81	-0,0377	100,43	0,1035	85,4	0,0440	9,13	0,0076	»	**0,1035**
1/9/1980	37,71	-0,0283	102,18	0,0174	82,9	-0,0293	10,27	0,0086	»	**0,0174**
1/10/1980	37,59	-0,0033	102,6	0,0041	80,9	-0,0241	11,62	0,0097	**Commodit.**	**0,0041**
1/11/1980	36,57	-0,0272	99,45	-0,0307	80,6	-0,0037	13,73	0,0114	»	**-0,0037**
1/12/1980	36,51	-0,0016	96,61	-0,0286	80,8	0,0025	15,49	0,0129	»	**0,0025**
1/1/1981	37,90	0,0382	96,85	0,0025	76,4	-0,0545	15,02	0,0125	»	**-0,0545**
1/2/1981	37,44	-0,0123	95,19	-0,0171	76	-0,0052	14,79	0,0123	»	**-0,0052**
1/3/1981	36,33	-0,0295	102,01	0,0716	74,7	-0,0171	13,36	0,0111	»	**-0,0171**
1/4/1981	37,65	0,0362	111,38	0,0919	75,4	0,0094	13,69	0,0114	»	**0,0094**
1/5/1981	36,36	-0,0342	109,12	-0,0203	74,6	-0,0106	16,3	0,0136	»	**-0,0106**
1/6/1981	38,09	0,0475	110,95	0,0168	72,4	-0,0295	14,73	0,0123	»	**-0,0295**
1/7/1981	37,38	-0,0186	107,63	-0,0299	70,1	-0,0318	14,95	0,0125	**Money mkt**	**-0,0318**
1/8/1981	36,15	-0,0328	104,03	-0,0334	73,6	0,0499	15,51	0,0129	»	**0,0125**
1/9/1981	35,84	-0,0413	97,59	-0,0933	69,9	-0,0029	14,7	0,0123	»	**0,0129**
1/10/1981	35,68	-0,0042	93,77	-0,0391	65,5	-0,0629	13,54	0,0113	**Bonds**	**0,0123**

This table covers one specific cycle, the same marked in the first diagram of this chapter, but the procedure we describe is the same for the whole period of interest. For the first day of every month in the table, we have, for each one of the four investment vehicles, one price and one return. For bonds, equities and commodities this return is the difference between this month's price and the previous month's price divided by the previous month's price. For the money market this return is the previous month's interest rate, which is received from the investor now after one month has passed. For example, at the 1st of September of 1981 the one-month interest rate is 0.0123. The investor receives the interest accrued at the 1st of October. So the investor who invests in the money market realizes at the 1st of October a return of 1.23% from his one-month investment. In the last two columns of the table we see when the investor who follows Economist's investment clock invests in one of the four vehicles and the return he succeeds from the investment of the previous month. Every entry of the last column shows a return, which is copied from the respective investment vehicle's cell. For example, at the 1/4/80 we enter in the first phase of a cycle and we invest in the bond index. At 1/5/80 we have earned a monthly return of 13.5%. Now let's clear out a technical detail: at 1/7/80 we enter in the second phase of a cycle and we invest, following the examined strategy, in the equity index. Nevertheless, the return shown at this date comes from investment in the bond index, since we invested in the bond index in the previous month and now we take the profits. Similarly, at 1/10/80 when we enter in the third phase of the cycle and we

invest in the commodity index, the return shown comes from the previous month's investment in the equity index. At 1/7/81 we enter in the fourth phase of the cycle and we invest in the money market. This cycle ends at 1/10/81 when we enter the first phase of a new cycle, investing in the bond index. We remind here that at 1/10/81 the return shown is the previous month's interest rate, which is now taken from the investor.

After we have computed the monthly returns we compare the cumulative performance of the investment strategy with that of the investment vehicles, first without taking account of the risk involved, with the following simple manner: we start with 100 units at time 0 and we make the investments suggested by Economist's investment clock. At the same time we start with 100 units and we invest at each of the four investment vehicles separately for the same period. We depict the investment performance of the strategy and that of the vehicles in a diagram in order to have a first comparison.

Stage 3: Computation and comparison of Sharpe ratios

Our next step is to compare the strategy's investment performance with every investment vehicle's performance using a measure of portfolio performance, which incorporates both return and risk into the analysis. We use a risk-adjusted measure of portfolio performance, which was introduced by William Sharpe and is called reward-to-variability ratio or more simply Sharpe ratio. Sharpe ratio measures the excess return per unit of total risk and can be computed from the following formula:

$$SR = \frac{R_p - R_f}{\sigma(R_p)}$$

where

SR = Sharpe ratio

R_p = the average return for a portfolio p during some period of time

R_f = the average risk-free rate of return during the period

$\sigma(R_p)$ = the standard deviation of return for portfolio p during the period

Using the above formula we compare the Sharpe ratio of the investment strategy proposed in the Economist's article with the Sharpe ratio of each investment vehicle and we come up to our final results.

Stage 4: Sensitivity analysis

The final step of this analysis is to perform a sensitivity analysis of the investment strategy examined, in order to compensate for the subjectivity of the identification of the cycle's phases. The sensitivity analysis moves in two directions, in the past and in the future. In order to take into account the fact that markets possibly discount economic news quite fast we perform sensitivity analyses which move one, two, three and six months in the past. To give an example let's return to the table presented above. According to our main scenario we enter in the first phase of a cycle at 1/4/80, investing in bonds. When we perform a sensitivity analysis that goes one month in the past we consider that we enter in the first phase of the same cycle one month before, at 1/3/80 and we move every monthly investment one month back to the past. To take into account the fact that there may be some lag in markets reaction to economic conditions we perform sensitivity analyses that move one, two, three and six months in the future. We think that with such a sensitivity analysis we monitor adequately the performance of the investment strategy and we can make meaningful comparisons among the results of each sensitivity analysis, even see if there is a consistently optimal point of time, which provides the best Sharpe ratio.

5.2 Ex post analysis for United States (Industrial production based)

This analysis was complementary and was performed in order to test the investment strategy examined when implementing the investment clock in industrial production's cycles. Industrial production's data are released every month in comparison with GDP data, which are quarterly released. We wanted to check the strategy with a more volatile variable, a variable that gives signals of economic activity in shorter intervals, enabling the investor to respond faster in changing economic conditions. The only difference of this analysis was that we identified the phases of the cycle and consequently we made the monthly investments based on

industrial production's cycles. So, after the phases had been identified we made every other step of the analysis described in the previous section.

5.3 Real-time analysis for the United States (GDP based)

This analysis was performed with the intention of testing the investment strategy proposed in real economic conditions. The separation of the four investment phases of the economic cycle was based exclusively on the real-time GDP data available to economic agents at a given reference date. We remind that real-time data sets do not incorporate revisions and definitional changes that occurred after the reference date. At this point we faced the problem of constructing a homogenous data series of the same scale, necessary for computing GDP growth rates from quarter to quarter. This could not happen because at each reference date the scale was changed. In order to surpass this problem we had to go at each reference date of FED's database, take the GDP data for the last two quarters and compute the growth rate from the one quarter to the next. With this way we constructed a real-time data series of homogenous growth rates. After that, in order to do GDP's smoothing, as in our previous analyses, we computed a four quarters moving average of growth rate. Our wish to check the strategy in real time guided us to a technical change concerning the separation of economic cycle's phases. In our previous two other analyses each phase and consequently each investment in the respective asset started at the first month of the quarter that signaled the beginning of the phase. Nevertheless, GDP data are released two months after the end of the reference quarter. For example, first quarter's GDP data are released in May. So, the investor who exists in a real economic environment outside the researcher's lab will invest in the chosen asset in May, as at this point of time he gets the information which guides him to the specific investment decision. Each phase and each investment in the appropriate investment vehicle, according Economist's investment clock starts two months after the reference quarter. The rest of the analysis is continued with the same methodology described in section 5.1. The only essential difference is that we do not perform here a sensitivity analysis because we are interested only in real-time conditions.

6. DATA DESCRIPTION

In this chapter we describe in detail the data used in every stage of this research and we discuss the problems we faced concerning these data. Three sections follow, one for each analysis performed.

6.1 Ex post analysis (GDP based)

The first stage of this analysis, that is the identification of the four investment phases suggested by Economist's investment clock, was dependent on the collection of GDP data. GDP data covered the period from 1971 to 2001 and were downloaded

from Thomson Financial DataStream. We worked with seasonally adjusted real quarterly GDP and we checked if the growth rates we computed were consistent with the growth rates released from OECD in its Quarterly National Accounts database.

During the second stage of the analysis, the construction of four data series, one for each investment vehicle used was necessary in order to compute monthly returns for the period of interest. The main problem we faced at that point was that there were no data available from 1971 for every vehicle. So, for each of the seven countries of interest, the analysis started from the period that data were available. Starting periods for each country's analysis are provided in the next table:

Country	Starting period
United States	1/1975
Japan	10/1974
Canada	1/1973
United Kingdom	7/1975
Germany	7/1974
France	1/1981
Italy	10/1977

We tried to use homogenous data for each country and we broke this rule only when, data series starting earlier were available, enabling us to prolong our analysis further in the past. The following table describes the data used for capturing the performance of each investment vehicle in every country:

Country	**Bond return**	**Equity return**	**Commodity return**	**Money market return**
US	US Benchmark 10 year DataStream Government Index	Americas DataStream Cyclical Consumer Goods Index	Economist Commodity All Industrials Index ($)	US Treasury Bill Secondary Market Rate on Discount Basis-3 Month
Available from	1/1980	2/1973	2/1971	1/1970
Japan	Japan Benchmark 3 year DataStream Government	Japan DataStream Cyclical Consumer Goods Index	Economist Commodity All Industrials Index ($), Exchange Rate adjusted	Japan 3 Month Certificates of Deposit
Available from	1/1982	1/1973	2/1971	2/1977
Canada	Scotia All	Canada DataStream	Economist Commodity	Canada 3 Month Treasury

	Government Long Term Index	Cyclical Service Index	All Industrials Index ($)	Bill Tender
Available from	1/1980	2/1973	2/1971	1/1970
UK	Financial Times British Government 5-15 years	UK DataStream Cyclical Consumer Goods Index	a) Economist Commodity All Industrials Index (£) b) Reuters Commodities Index	UK Treasury Bill Rate - Discount 3 Month
Available from	1/1976	1/1970	a) 2/1971 to 5/2001 b) 2/1976	1/1970
Germany	a) Germany BHF Bank Bond Index (Dead) b) BD Benchmark 10 year DataStream Government Index	Germany DataStream Cyclical Consumer Goods Index	Economist Commodity All Industrials Index ($), Exchange Rate adjusted	Germany 3 Month Deposit rates under 1 Million DM
Available from	a) 1/1970 to 12/2000 used from 1/1970 to 1/1980 b) 1/1980	1/1973	2/1971	2/1970
France	France Benchmark 10 year DataStream Government Index	France DataStream Cyclical Consumer Goods Index	Economist Commodity All Industrials Index ($), Exchange Rate adjusted	France Treasury Bill Rate
Available from	2/1985	1/1973	2/1971	1/1970
Italy	JP Morgan Italy Government Italian Lire Index	Italy DataStream Cyclical Consumer Goods Index	Economist Commodity All Industrials Index ($), Exchange Rate adjusted	Italy 3 Month Treasury Bill Rate
Available from	1/1988	1/1973	2/1971	1/1974

The data described above were downloaded from Thomson Financial DataStream. We used total return indices for bonds and equities, while price indices were preferred for commodities. Apart from United States and United Kingdom, for which Economist Commodity index is released in the local currency ($ and British pound respectively), the index is multiplied with the respective period's exchange rate (domestic currency to $) in order to capture real return for the investor in one of the other five countries. Some times we used two different indices to capture one investment vehicle's return because although the first index used had been available from an earlier date, stopped being released after some period.

6.2 Ex post analysis for United States (Industrial production based)

The difference of this analysis from the previous one is that the identification of the investment phases was based on industrial production cycles instead of GDP cycles. So, the only additional data needed were industrial production data covering the same period from 1971 to 2001. We worked with a seasonally adjusted volume index of industrial production, which was downloaded from Thomson Financial DataStream. The data used for capturing the performance of the four investment vehicles for the United States were the same with those described in the last table of the previous section.

6.3 Real-time analysis for the United States (GDP based)

The main difference of this analysis is that the separation of the four investment phases of the economic cycle was based exclusively on the real-time GDP data available to economic agents at a given reference date. The GDP data used in this analysis were downloaded from the Federal Reserve Bank of Philadelphia, from a database called «Real Time Data Set for Macroeconomists». The data used for capturing the performance of the four investment vehicles for the United States are the same with those described in the last table of section 6.1.

7. EMPIRICAL RESULTS

In this chapter we present the empirical results of our research work without any subjectivity, leaving enough room for anyone's personal interpretation. Three sections follow, one for each analysis performed.

7.1 Ex post analysis (GDP based)

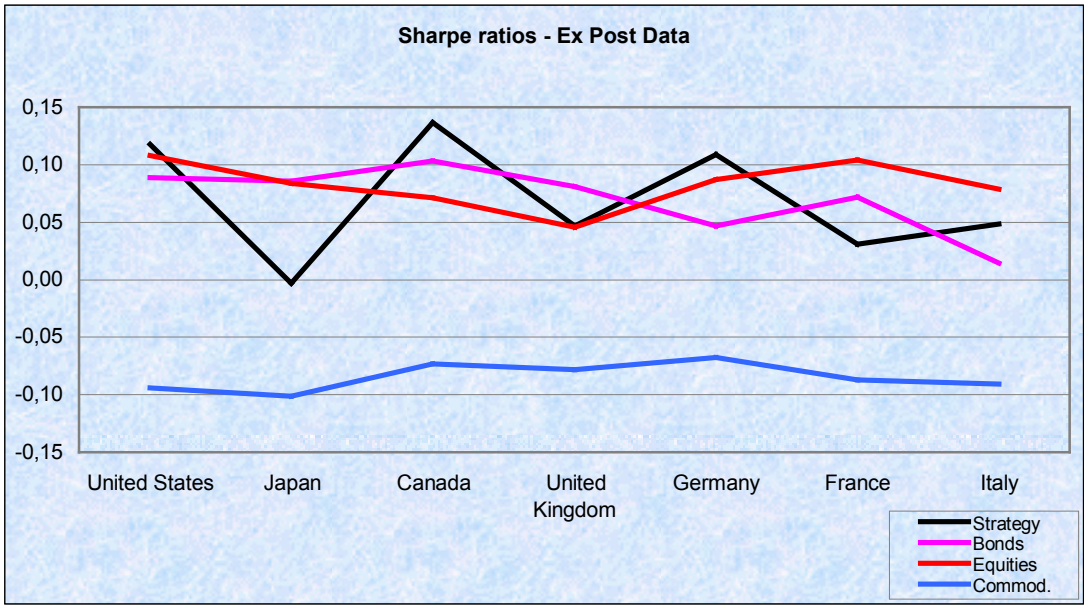
The presentation of the results for each of the seven countries consists of the following parts:

- A graph, showing the evolution of growth rate from 1971 to 2001.
- A table, showing the investment phases, which depends on the previous graph.
- A graph depicting the cumulative return of a 100 units investment in the examined strategy, compared with the cumulative returns of the other four investment vehicles.
- A table with the final results, that is the Sharpe ratios of the strategy and of each one of the four assets.
- A table with the Sharpe ratios of the strategy under every sensitivity analysis scenario.
- A graph of the sensitivity analysis results

Before proceeding to every country's results separately let's see the final results of the seven countries in order to have a first summary picture.

Sharpe ratios	Strategy	Bonds	Equities	Commod.
United States	**0,11745**	0,08863	0,10765	-0,09372
Japan	-0,00290	**0,08562**	0,08364	-0,10117
Canada	**0,13662**	0,10337	0,07136	-0,07286
United Kingdom	0,04659	**0,08108**	0,04573	-0,07806
Germany	**0,10856**	0,04660	0,08693	-0,06754
France	0,03089	0,07182	**0,10430**	-0,08701
Italy	0,04843	0,01438	**0,07854**	-0,09086

We have marked the investment choice with the best Sharpe ratio for each country. Strategy outperforms the other investment vehicles only in United States, in Canada and in Germany. Bonds outperform the four alternative investments in Japan and in the United Kingdom, while equities are the best performing asset in France and Italy. Commodities give consistently the worse results, negative in every country. A graphical representation of the previous table follows:

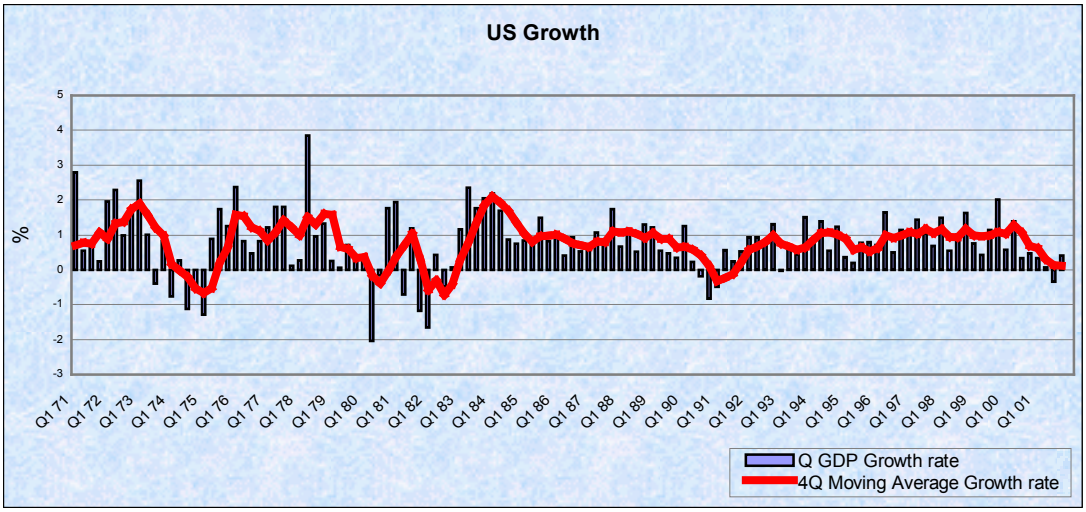


Strategy's Sharpe ratio takes its highest value in Canada, with the greatest difference from then second asset. So, Economist's investment clock seems to work more effectively in Canada. On the other hand, in Japan investment clock gives its worst performance with a negative Sharpe ratio. It is interesting in the above diagram that although, in United States, equities give the highest Sharpe ratio from every other country, they are outperformed by the strategy. But let's see every country in detail.

7.1.1 United States

The first graph below depicts the country's GDP growth rate from 1971 to 2001. We stand at the period from the fourth quarter of 1982 to the second quarter of 2001, with the exception of three quarters in 1990-1991, during which US

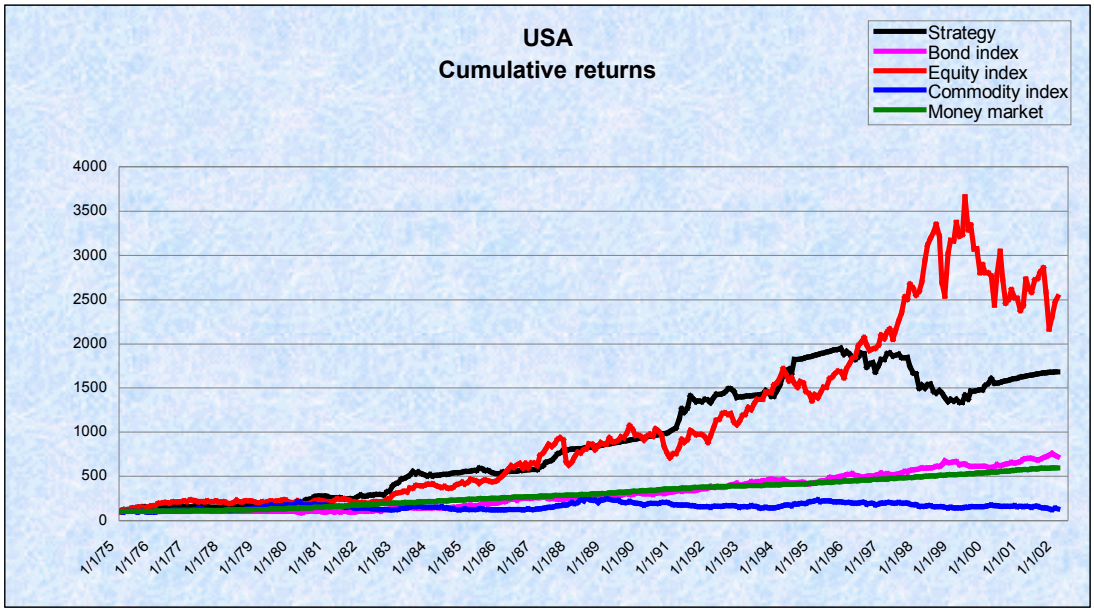
experienced a remarkable period of sustainable growth and played the role of locomotive in world economy.



The identification of the investment phases of the cycle is based on the four quarters moving average of growth rate and can be seen in the table below. The starting period of the analysis is January of 1975.

Investment Phases									
Start date	Asset	Start date	Asset	Start date	Asset	Start date	Asset	Start date	Asset
1/1975	**Equit.**	4/1980	**Bonds**	7/1982	**Equit.**	1/1987	**Com.**	10/1992	**Money**
7/1975	**Com.**	7/1980	**Equit.**	1/1983	**Com.**	10/1987	**Money**	7/1993	**Com.**
1/1976	**Money**	10/1980	**Com.**	1/1984	**Money**	10/1990	**Bonds**	7/1994	**Money**
1/1977	**Com.**	7/1981	**Money**	4/1985	**Com.**	1/1991	**Equit.**	10/1995	**Com.**
10/1978	**Money**	10/1981	**Bonds**	1/1986	**Money**	10/1991	**Com.**	4/2000	**Money**

Next graph depicts the cumulative returns of the strategy examined and that of the four assets, from January of 1975 to December of 2001:



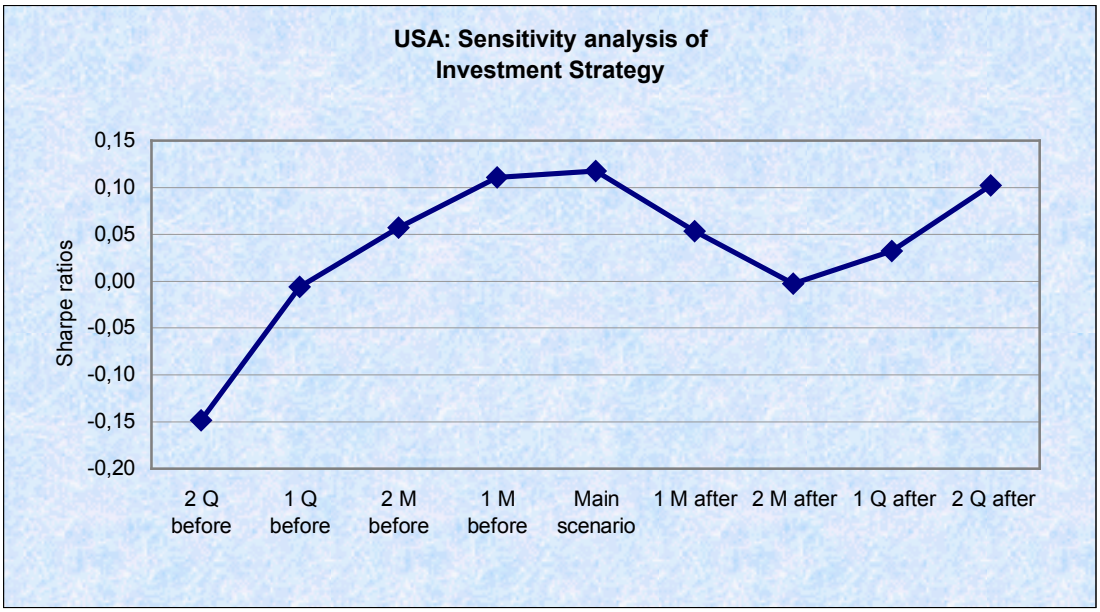
Equities outperform the other investment choices, if we do not take into account the risk associated with these investments, but if we compute Sharpe ratios we get the following results:

Sharpe ratios	**Strategy**	**Bonds**	**Equities**	**Commod.**
	0,11745	**0,08863**	**0,10765**	**-0,09372**

The investment strategy examined has the highest Sharpe ratio, showing that Economist's investment clock works for the US. It is interesting that, despite US stock market boom after 1992, strategy gives the highest Sharpe ratio, without investing at any period after 1992 in equities. Sensitivity analysis gives the following results for the strategy:

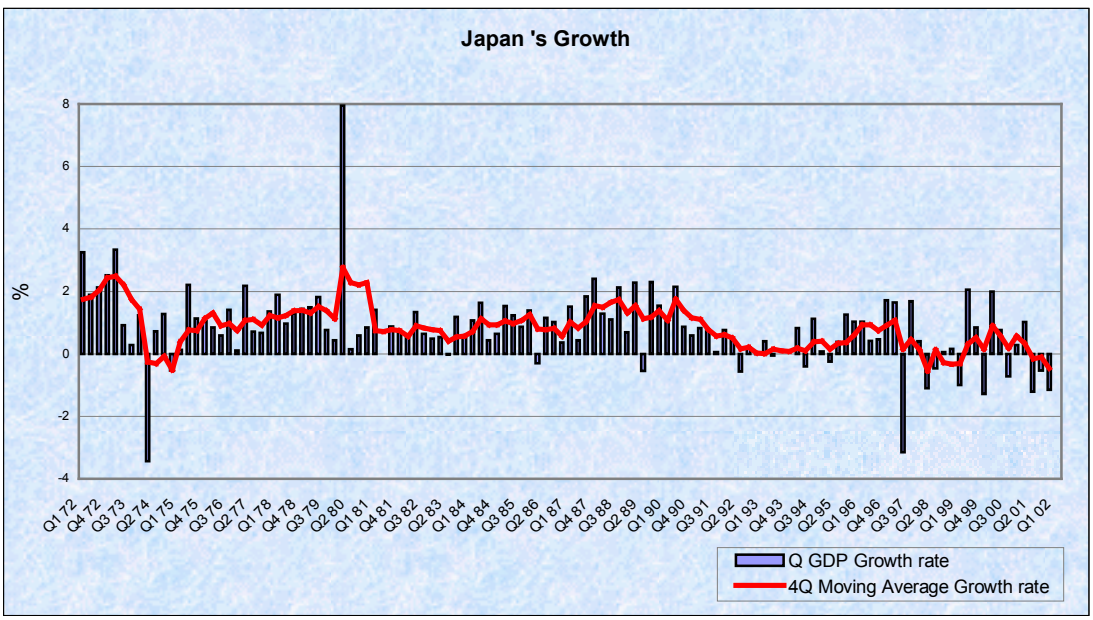
Sensitivity analysis	
Start of the phase	Strategy's Sharpe Ratio
2 Q before	-0,14797
1 Q before	-0,00611
2 M before	0,05715
1 M before	0,11101
1 M after	0,05309
2 M after	-0,00229
1 Q after	0,03203
2 Q after	0,10207

It is interesting that main scenario gives the best results from every sensitivity analysis scenario. Let's finally depict the above table in a graph:



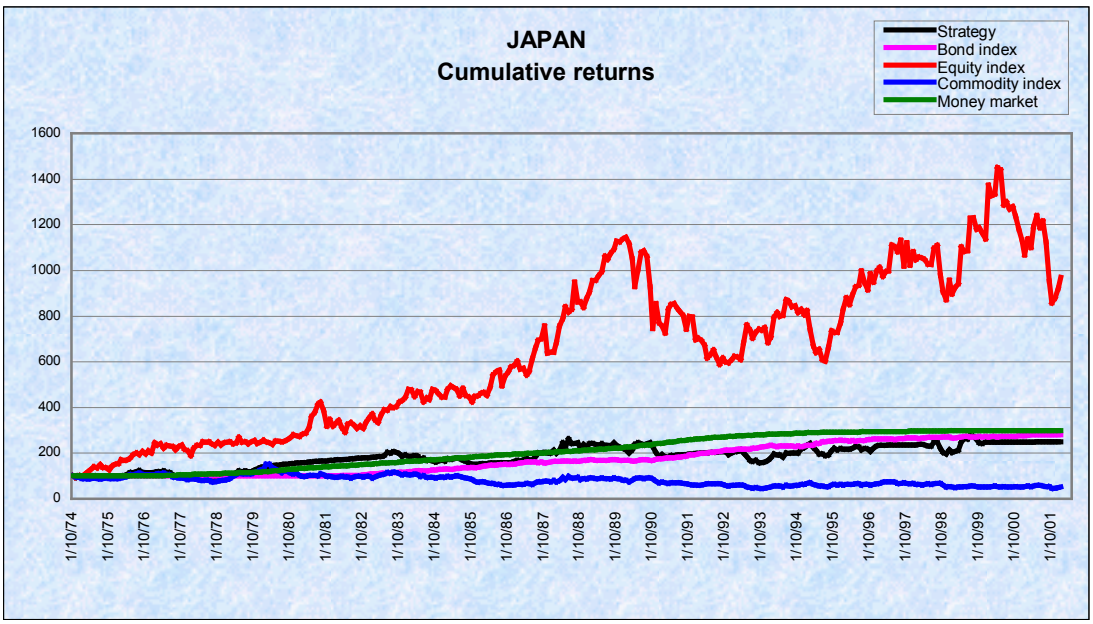
7.1.2 Japan

Japan's growth after a period of remarkable performance has been very unstable and feeble since 1992, as can be seen in the diagram below:



The analysis starts in October 1974 and the investment phases are:

Investment Phases					
Start date	Asset	Start date	Asset	Start date	Asset
10/1974	**Equit.**	10/1986	**Com.**	1/1998	**Equit.**
1/1975	**Com.**	4/1991	**Money**	4/1999	**Com.**
1/1980	**Money**	10/1992	**Com.**	1/2000	**Money**
4/1983	**Com.**	1/1997	**Money**	4/2001	**Bonds**
10/1985	**Money**	10/1997	**Bonds**		

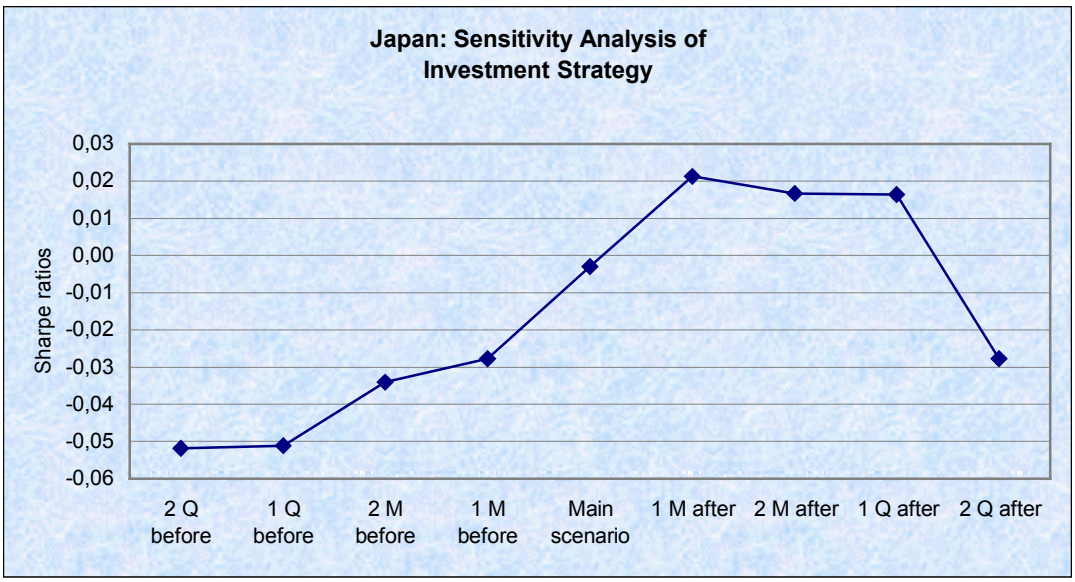


Cumulative returns show a better performance for equities, but taking risk into account bonds slightly outperform equities. Bonds superiority is explained from the sharp decline of interest rates in the nineties due to Japanese economy's weakness (3-Month certificates of deposit returned 8.18% in January of 1991, but only 0.26% in December of 1999). Nevertheless, going back to cumulative returns money market looks the best investment choice, considering the lack of any risk at all.

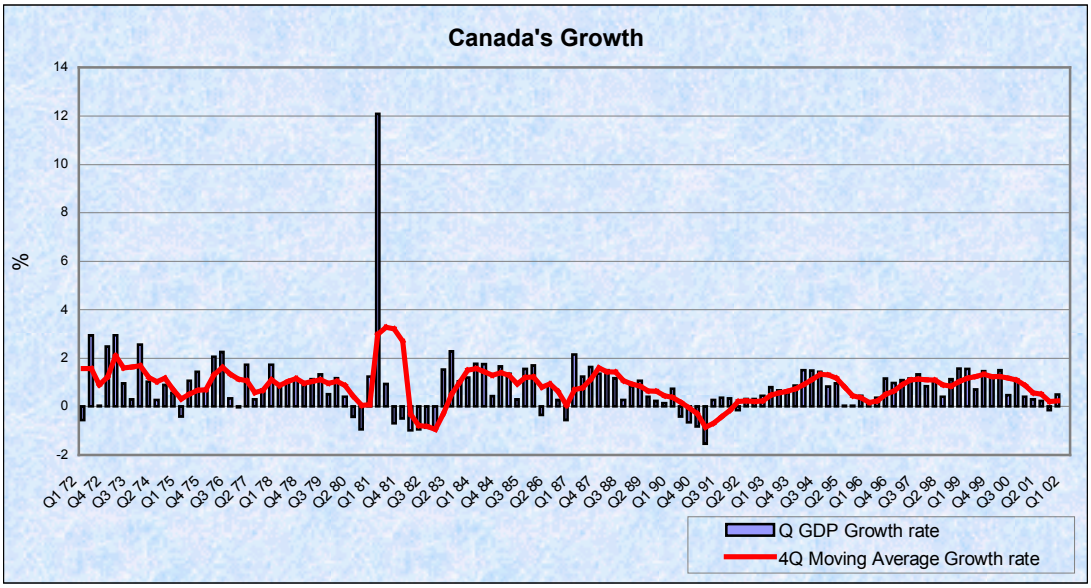
Sharpe ratios	**Strategy**	**Bonds**	**Equities**	**Commod.**
	-0,002896	**0,085617**	**0,083640**	**-0,101173**

Sensitivity Analysis	
Start of the phase	Strategy's Sharpe Ratio
2 Q before	-0,051824
1 Q before	-0,051118
2 M before	-0,034011
1 M before	-0,027731
1 M after	**0,021242**
2 M after	0,016677
1 Q after	0,016429
2 Q after	-0,027707

Sensitivity analysis gives the best Sharpe ratio for 1-Month-after scenario and with a positive sign, but still the distance from the bond's ratio is long.

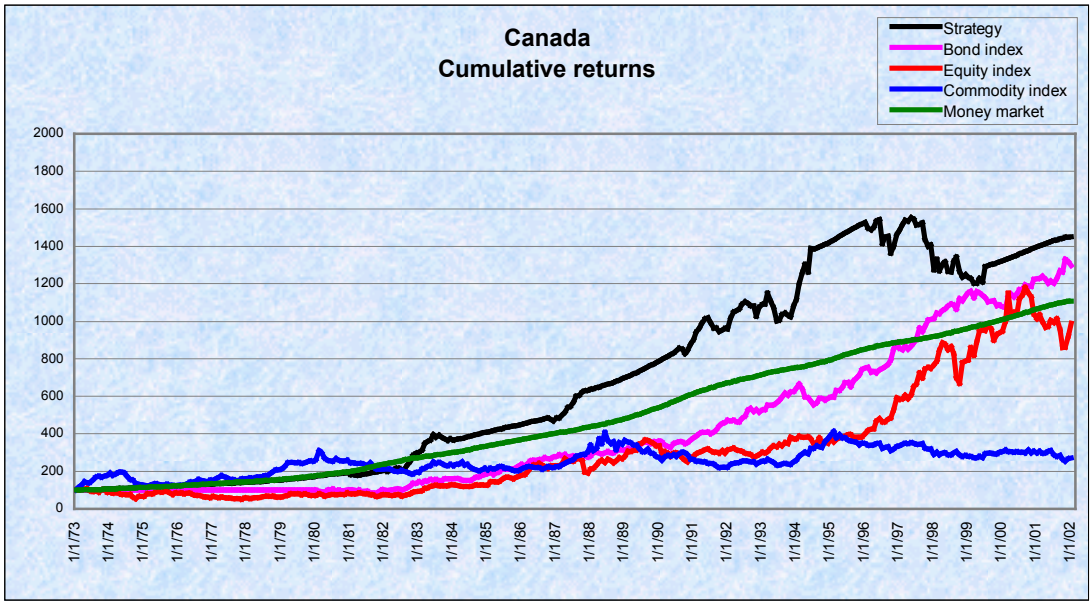


7.1.3 Canada



The analysis for Canada starts in January of 1973 and the investment phases are:

Investment Phases							
Start date	Asset	Start date	Asset	Start date	Asset	Start date	Asset
1/1973	**Money**	1/1982	**Bonds**	10/1987	**Money**	1/1996	**Com.**
1/1975	**Com.**	10/1982	**Equit.**	7/1990	**Bonds**	7/1999	**Money**
4/1976	**Money**	4/1983	**Com.**	1/1991	**Equit.**		
10/1980	**Com.**	1/1984	**Money**	10/1991	**Com.**		
4/1981	**Money**	10/1986	**Com.**	7/1994	**Money**		

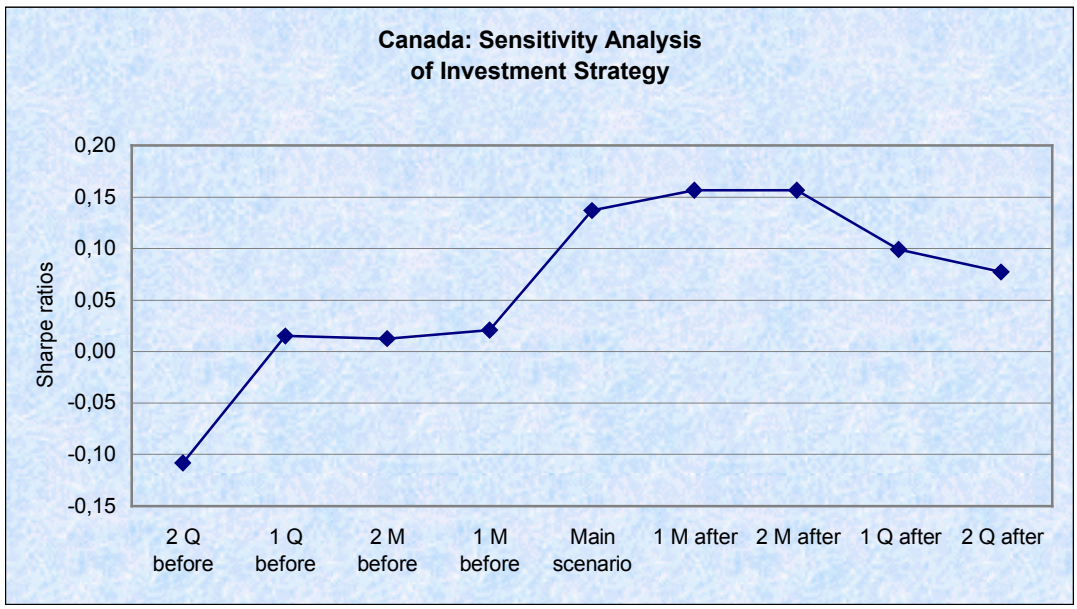


For Canada cumulative returns and Sharpe ratios give the same results. The Economist's investment clock outperforms the other vehicles even if we do not take into account the risk involved. Strategy's greater performance is explained from the high interest rates prevailing in Canadian economy from 1970 to 1992. If we look again at the previous diagram Canada is the only country analysed where money market gives a greater cumulative return than equities.

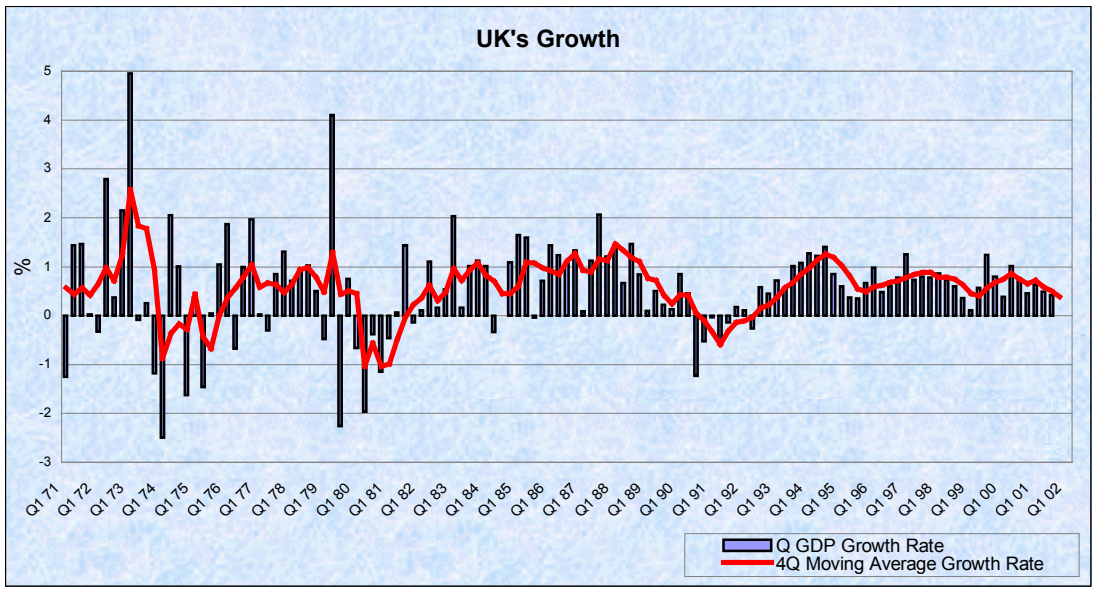
Sharpe ratios	**Strategy**	**Bonds**	**Equities**	**Commod.**
	0,136622	**0,103374**	**0,071365**	**-0,072861**

Sensitivity Analysis	
Start of the phase	Strategy's Sharpe Ratio
2 Q before	-0,108152
1 Q before	0,014919
2 M before	0,012459
1 M before	0,020736
1 M after	**0,156681**
2 M after	0,156643
1 Q after	0,098887
2 Q after	0,077447

Sensitivity analysis gives better Sharpe ratios for 1 and 2-Month-after scenarios. It is interesting that the 1-Month-before-scenario gives a dramatically worse Sharpe ratio for the strategy, showing the importance of investment timing.



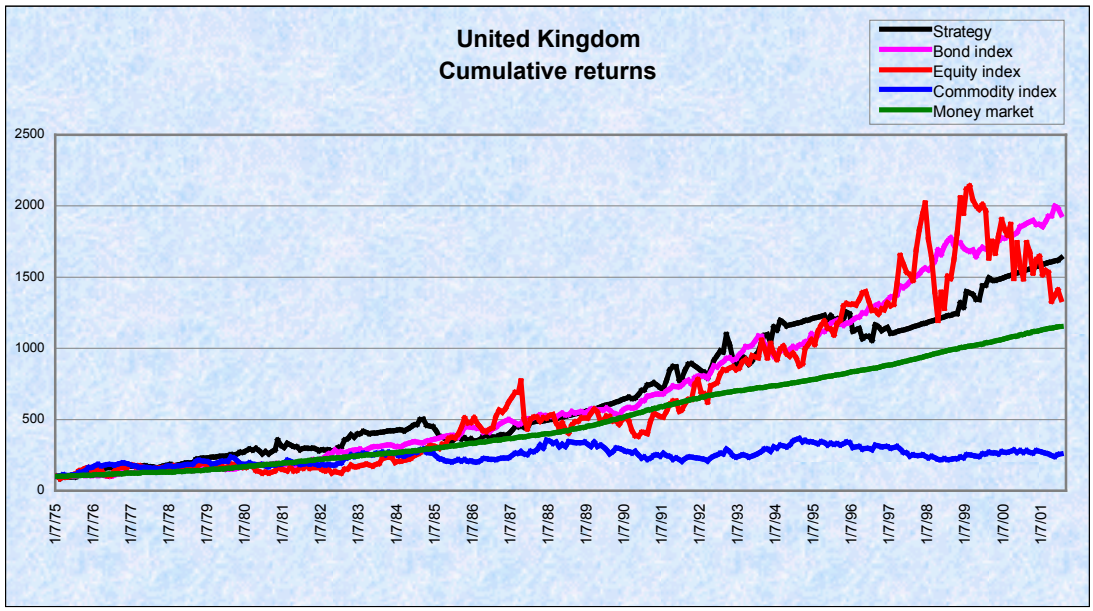
7.1.4 United Kingdom



The analysis for UK starts in July of 1975 and the investment phases are:

Investment Phases							
Start date	Asset	Start date	Asset	Start date	Asset	Start date	Asset
7/1975	**Equit.**	1/1980	**Bonds**	1/1988	**Money**	10/1995	**Com.**
10/1975	**Com.**	10/1980	**Equit.**	7/1990	**Bonds**	7/1997	**Money**
10/1976	**Money**	7/1981	**Com.**	4/1991	**Equit.**	4/1999	**Com.**
10/1977	**Com.**	10/1983	**Money**	4/1992	**Com.**	4/2000	**Money**

4/1979	**Money**	7/1984	**Com.**	10/1994	**Money**		



Bonds prove the best performing asset whether we use cumulative returns or Sharpe ratios as a measure of evaluation. Strategy outperforms equities also with both measures.

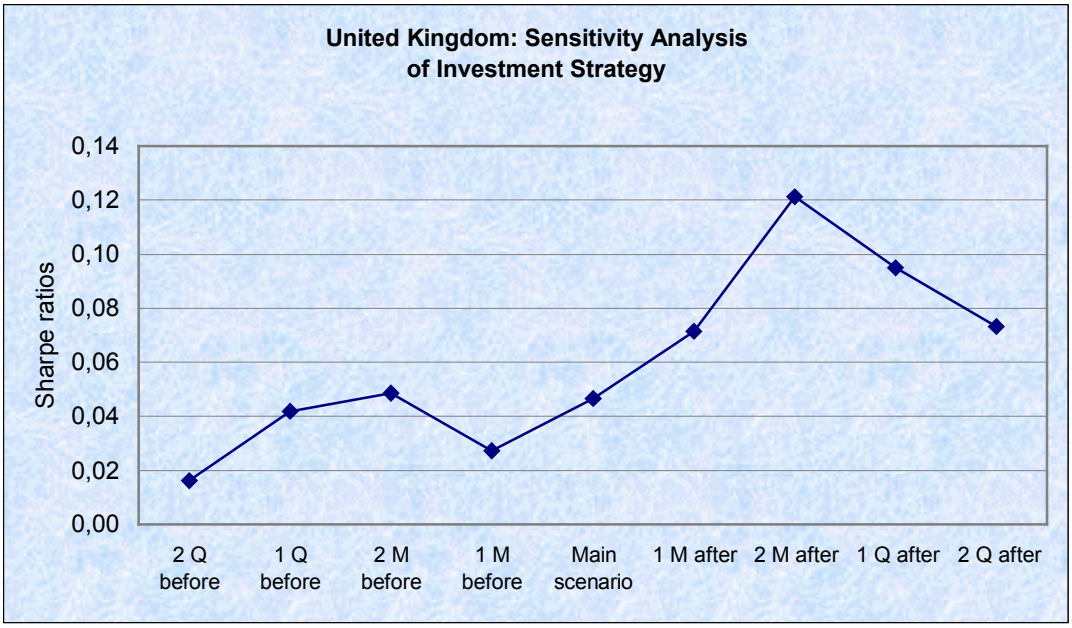
Sharpe ratios	**Strategy**	**Bonds**	**Equities**	**Commod.**
	0,046594	**0,081077**	**0,045727**	**-0,078055**

The fact that we have different Sharpe ratios ranking from the US, despite similar growth evolution, is largely due to the interest rates decline differential from January 1990 to December 2000 in the two countries. During this period, in UK 3-MonthTreasury Bill rate fell from 14.5% to 5.875%, while in US 3-month Treasury Bill fell from 7,64% to 5,77%. The sharper decline in interest rates in UK explains the outperformance of bonds.

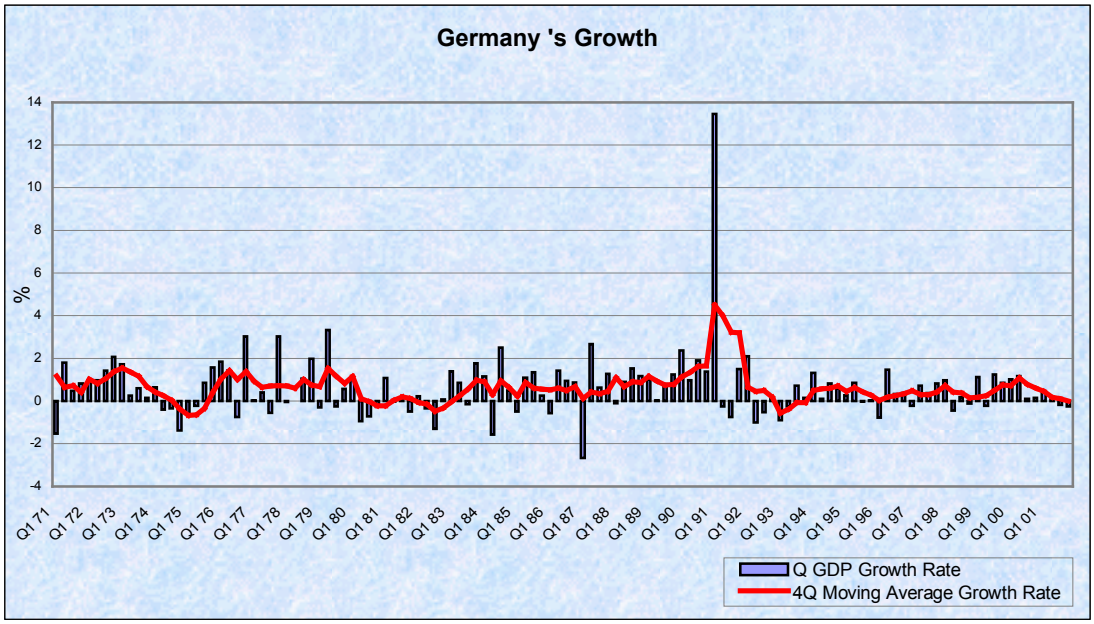
Sensitivity Analysis	
Start of the phase	Strategy's Sharpe Ratio
2 Q before	0,016139
1 Q before	0,041918
2 M before	0,048619
1 M before	0,027309
1 M after	0,071515

2 M after	**0,121272**
1 Q after	0,094936
2 Q after	0,073354

Although bonds outperform strategy under our main scenario, sensitivity analysis shows that under the 2-Month-after and 1-Quarter-after scenarios the strategy fares best. Especially in 2-Month-after scenario we find the second highest Sharpe ratio of ex-post analysis. So, perhaps investment clock works for the UK also, but maybe timing is different.

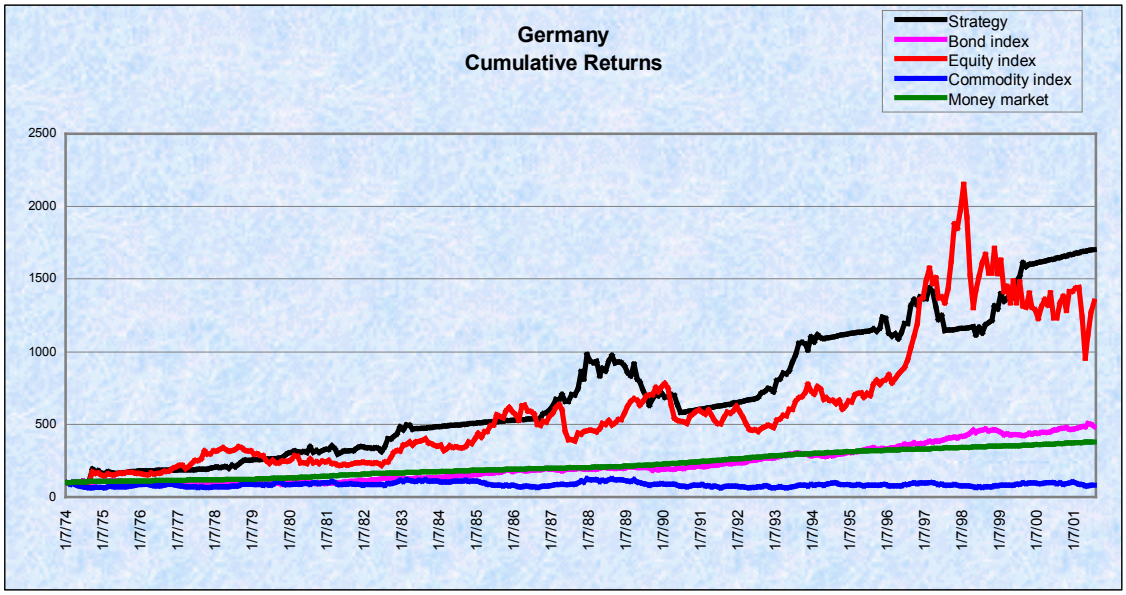


7.1.5 Germany



The analysis for Germany starts in July of 1974 and the investment phases are:

Investment Phases									
Start date	Asset	Start date	Asset	Start date	Asset	Start date	Asset	Start date	Asset
7/1974	**Bonds**	4/1979	**Money**	7/1982	**Equit.**	10/1992	**Bonds**	1/1998	**Money**
1/1975	**Equit.**	4/1980	**Bonds**	1/1983	**Com.**	1/1993	**Equit.**	10/1998	**Com.**
10/1975	**Com.**	10/1980	**Equit.**	10/1983	**Money**	10/1993	**Com.**	4/2000	**Money**
4/1976	**Money**	4/1981	**Com.**	1/1987	**Com.**	10/1994	**Money**		
4/1978	**Com.**	10/1981	**Bonds**	1/1991	**Money**	1/1996	**Com.**		

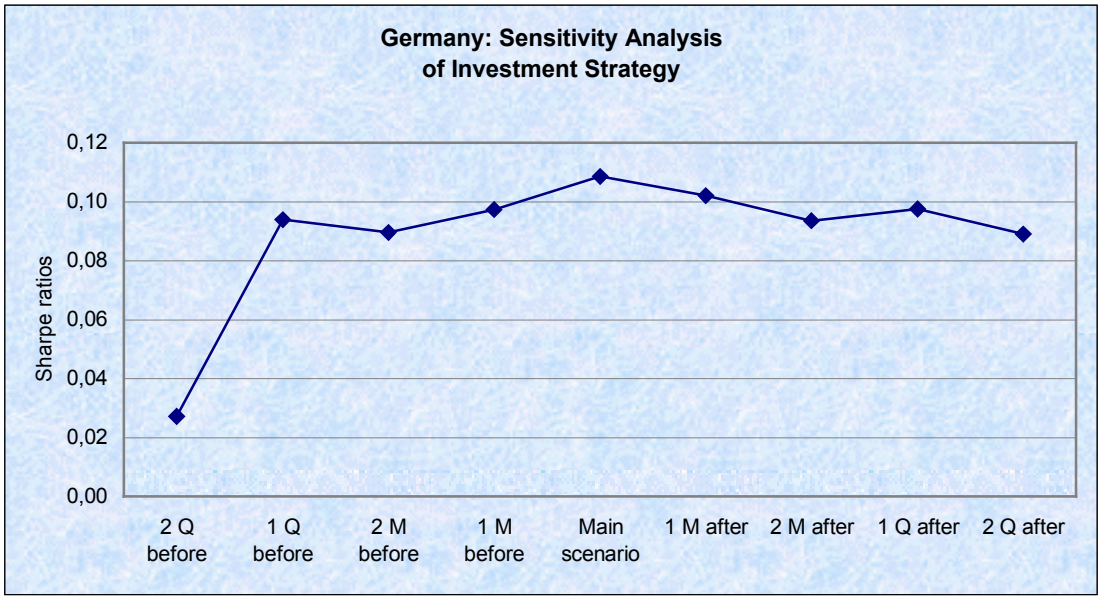


The strategy outperforms the other assets whether we use cumulative returns or Sharpe ratios as a measure of evaluation.

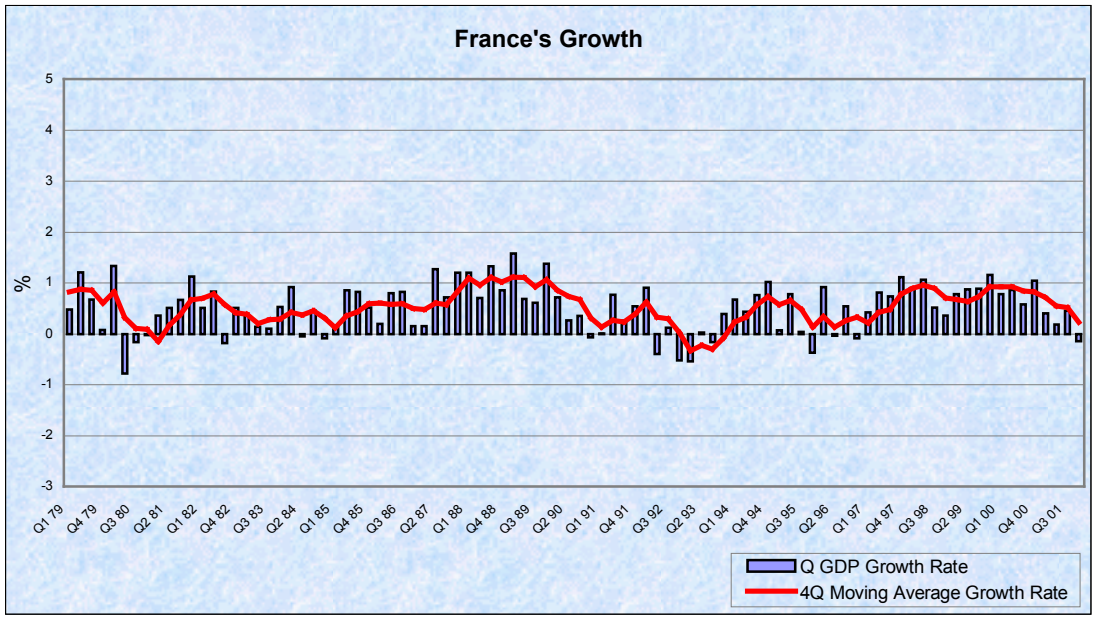
Sharpe ratios	**Strategy**	**Bonds**	**Equities**	**Commod.**
	0,108562	**0,046595**	**0,086927**	**-0,067544**

Sensitivity Analysis	
Start of the phase	Strategy's Sharpe Ratio
2 Q before	0,027100
1 Q before	0,093910
2 M before	0,089538
1 M before	0,097299
1 M after	0,102125
2 M after	0,093529
1 Q after	0,097572
2 Q after	0,089055

It is interesting that, like in the United States, main scenario gives the best results for the strategy. Apart from 2-Q-before scenario, under every other sensitivity analysis scenario strategy outperforms other assets. So, investment clock seems to work in Germany and with a greater elasticity concerning its timing.



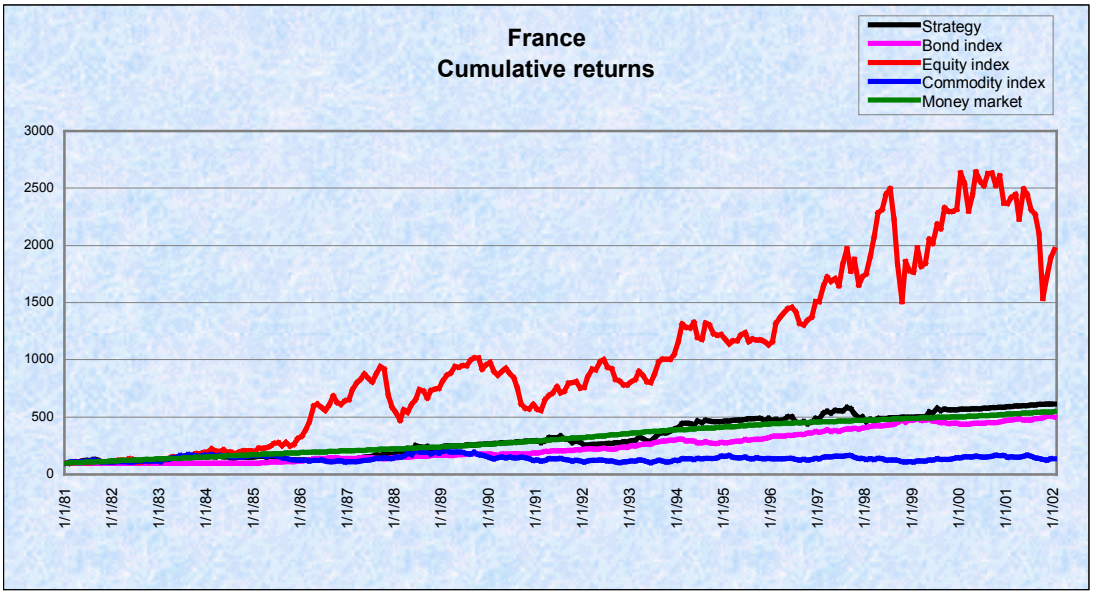
7.1.6 France



The analysis for France starts at January of 1981 and the investment phases are:

Investment Phases							
Start date	Asset	Start date	Asset	Start date	Asset	Start date	Asset
1/1981	**Equit.**	1/1985	**Com.**	1/1992	**Money**	10/1995	**Com.**
4/1981	**Com.**	10/1985	**Money**	10/1992	**Bonds**	4/1998	**Money**
4/1982	**Money**	1/1987	**Com.**	1/1993	**Equit.**	4/1999	**Com.**

4/1983	**Com.**	1/1989	**Money**	10/1993	**Com.**	10/1999	**Money**
7/1984	**Money**	1/1991	**Com.**	10/1994	**Money**		

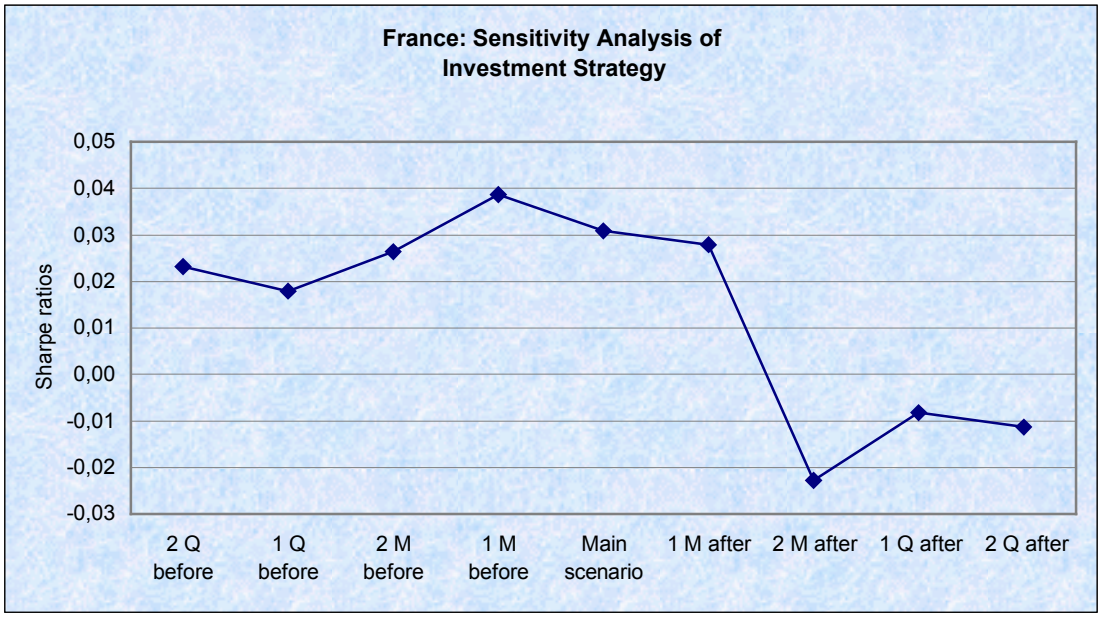


Equities clearly outperform the strategy and the other assets, whether we compare cumulative returns or Sharpe ratios. Investment clock in France gives its second worst performance after Japan, being far away from bonds and equities performance.

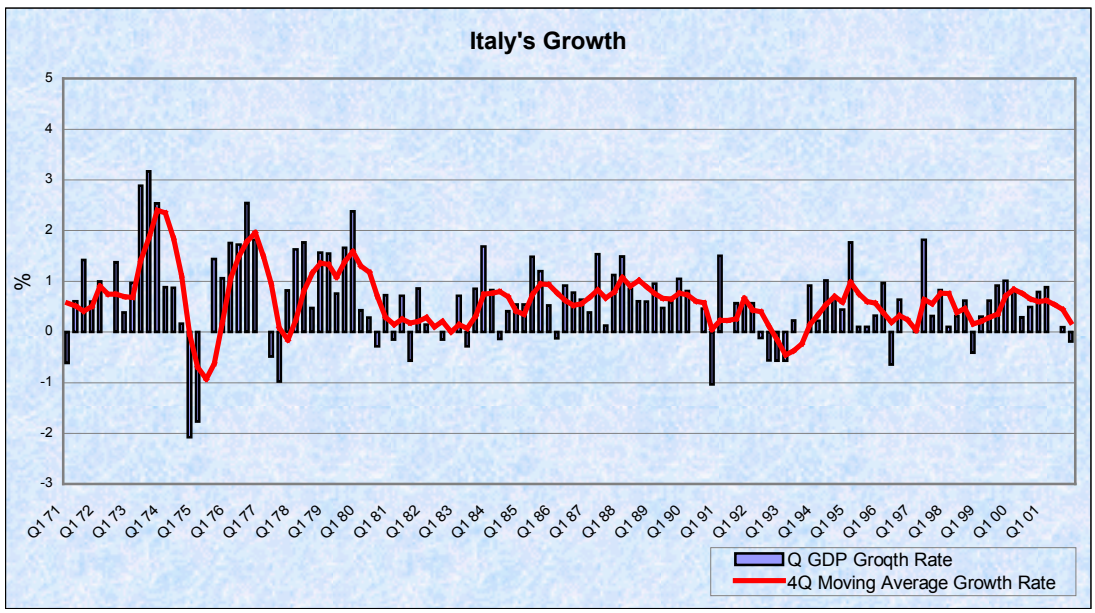
Sharpe ratios	**Strategy**	**Bonds**	**Equities**	**Commod.**
	0,030893	**0,071819**	**0,104300**	**-0,087009**

Sensitivity Analysis	
Start of the phase	Strategy's Sharpe Ratio
2 Q before	0,023171
1 Q before	0,017913
2 M before	0,026442
1 M before	**0,038614**
1 M after	0,027834
2 M after	-0,022767
1 Q after	-0,008198
2 Q after	-0,011266

Sensitivity analysis shows that the 1-Month-before scenario gives the best Sharpe ratio for the strategy.



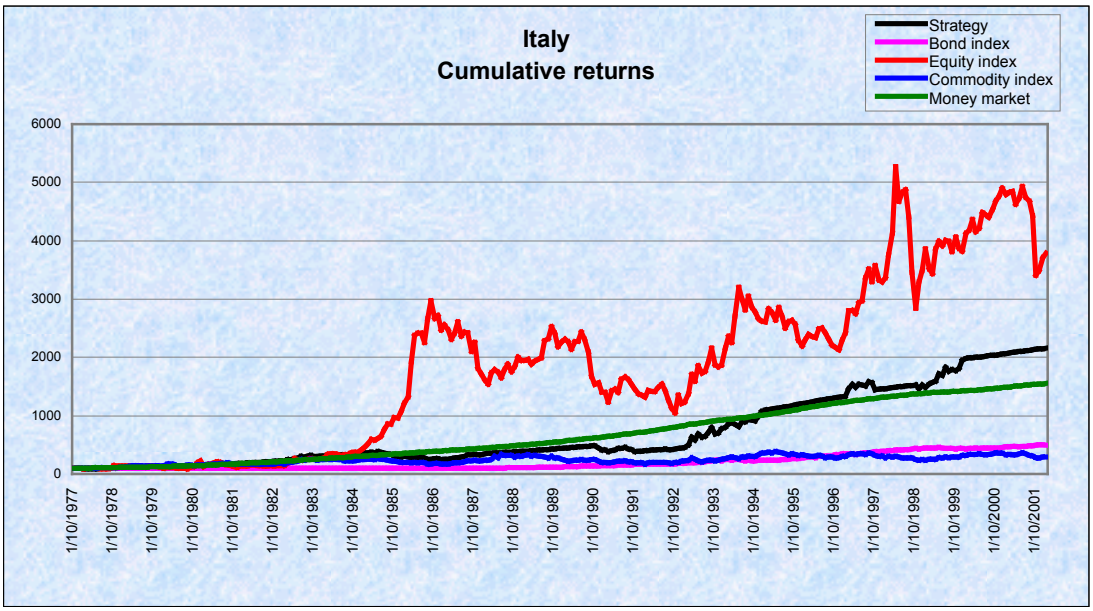
7.1.7 Italy



The analysis for Italy starts in October of 1977 and the investment phases are:

Investment Phases							
Start date	Asset	Start date	Asset	Start date	Asset	Start date	Asset

10/1977	**Equit.**	1/1985	**Com.**	1/1993	**Equit.**	10/1998	**Com.**
1/1978	**Com.**	1/1988	**Money**	10/1993	**Com.**	1/2000	**Money**
10/1979	**Money**	10/1990	**Com.**	1/1995	**Money**		
10/1982	**Com.**	10/1991	**Money**	1/1997	**Com.**		
4/1984	**Money**	7/1992	**Bonds**	10/1997	**Money**		

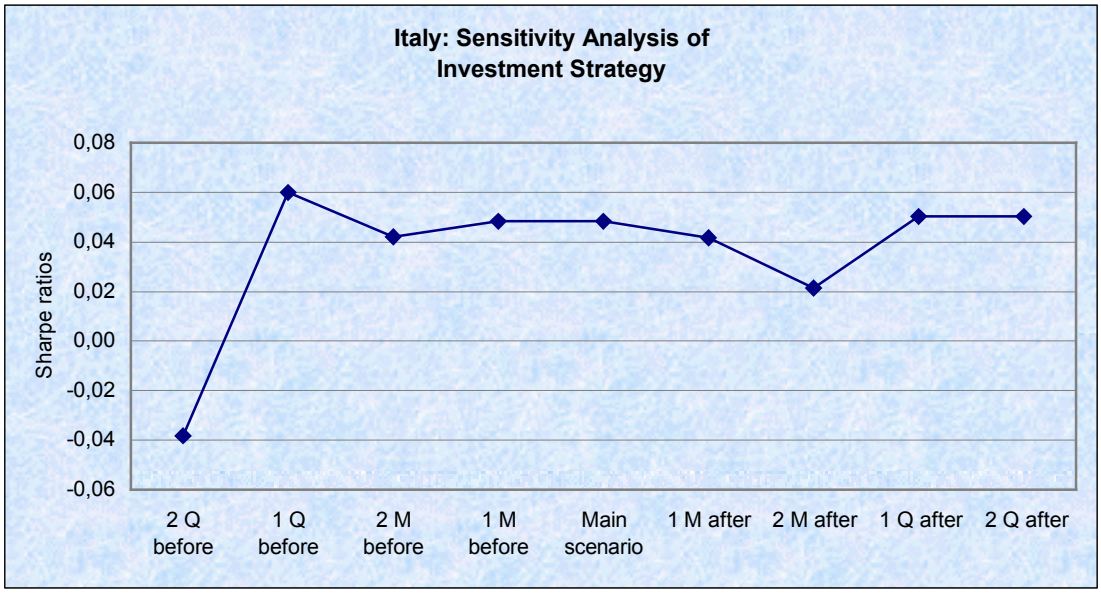


Equities clearly outperform the strategy and the other assets, whether we compare cumulative returns or Sharpe ratios.

Sharpe ratios	**Strategy**	**Bonds**	**Equities**	**Commod.**
	0,048433	0,014379	0,078538	-0,090864

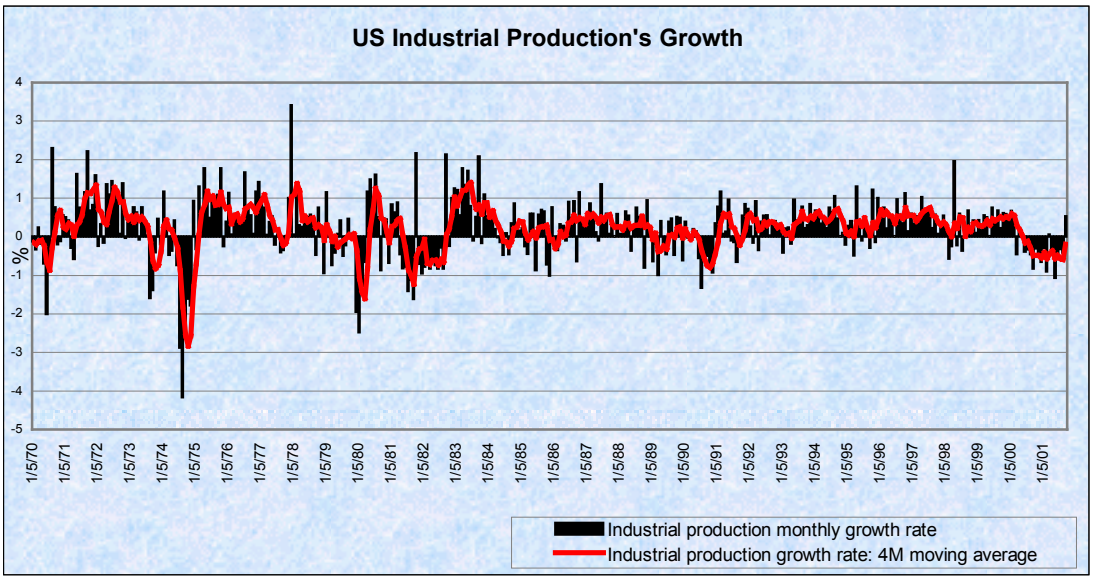
Sensitivity Analysis	
Start of the phase	Strategy's Sharpe Ratio
2 Q before	-0,038185
1 Q before	**0,059873**
2 M before	0,042094
1 M before	0,048384
1 M after	0,041666
2 M after	0,021425
1 Q after	0,050378
2 Q after	0,050377

Sensitivity analysis shows that the 1 Quarter before scenario gives the best Sharpe ratio for the strategy.



7.2 Ex post analysis for United States (Industrial production based)

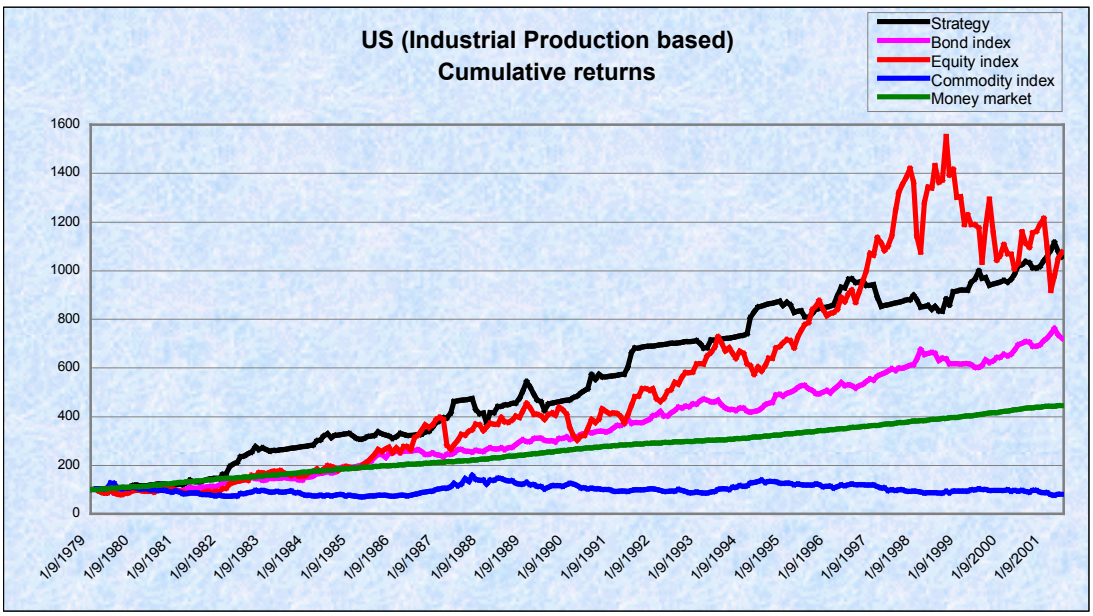
The presentation of the results of this analysis follows the same structure with the previous section.



The analysis starts in September of 1979 and the investment phases are:

Investment Phases									
Start date	Asset	Start date	Asset	Start date	Asset	Start date	Asset	Start date	Asset

9/1979	**Equit.**	1/1983	**Com.**	12/1986	**Money**	5/1991	**Com.**	11/1995	**Money**
3/1980	**Bonds**	10/1983	**Money**	4/1987	**Com.**	7/1991	**Money**	1/1996	**Com.**
7/1980	**Equit.**	10/1984	**Bonds**	1/1988	**Money**	12/1991	**Bonds**	5/1996	**Money**
9/1980	**Com.**	12/1984	**Equit.**	6/1988	**Com.**	1/1992	**Equit.**	10/1996	**Com.**
11/1980	**Money**	1/1985	**Com.**	1/1989	**Money**	2/1992	**Com.**	11/1997	**Money**
4/1981	**Com.**	4/1985	**Money**	6/1989	**Bonds**	5/1992	**Money**	7/1998	**Com.**
8/1981	**Money**	7/1985	**Com.**	7/1989	**Equit.**	8/1993	**Com.**	10/1998	**Money**
9/1981	**Bonds**	2/1986	**Money**	11/1989	**Com.**	12/1993	**Money**	12/1998	**Com.**
1/1982	**Equit.**	3/1986	**Bonds**	3/1990	**Money**	9/1994	**Com.**	5/2000	**Money**
5/1982	**Bonds**	4/1986	**Equit.**	9/1990	**Bonds**	1/1995	**Money**	9/2000	**Bonds**
6/1982	**Equit.**	5/1986	**Com.**	2/1991	**Equit.**	7/1995	**Com.**		



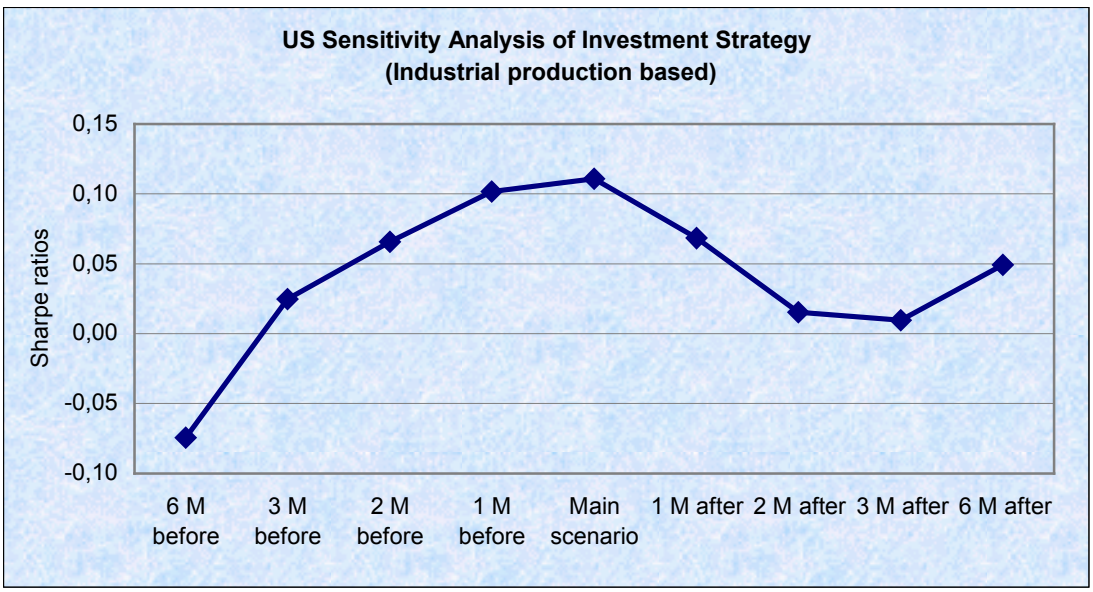
As in the US GDP based analysis, we have the same results. Equities outperform the other investment choices, if we do not take into account the risk associated with these investments, but this time their difference from the strategy is trivial.

Sharpe ratios	**Strategy**	**Bonds**	**Equities**	**Commod.**
	0,11057	**0,08647**	**0,08637**	**-0,12964**

If we use Sharpe ratios strategy gives the best results. The most important element that occurs from this analysis is that the difference of the strategy's Sharpe ratio from the equities Sharpe ratio is larger than in the US GDP-based analysis.

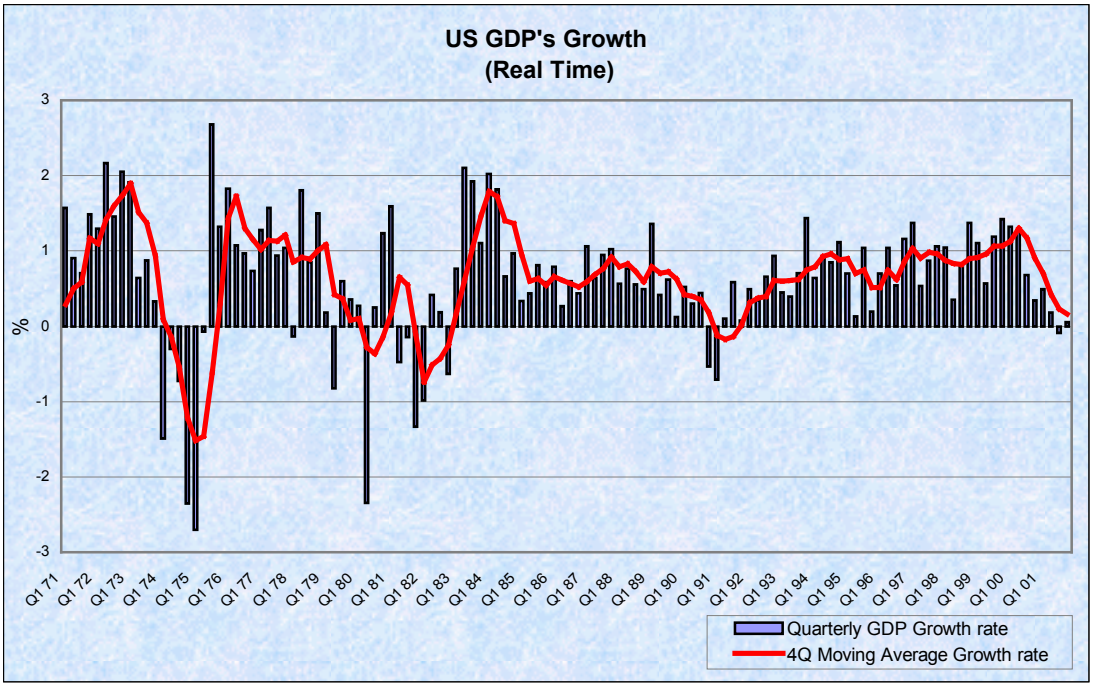
Sensitivity Analysis	
Start of the phase	Strategy's Sharpe Ratio
6 M before	-0,07447
3 M before	0,02464
2 M before	0,06578
1 M before	0,10163
1 M after	0,06813
2 M after	0,01516
3 M after	0,00940
6 M after	0,04908

Main scenario gives the best results for the strategy, like in the US GDP based analysis.



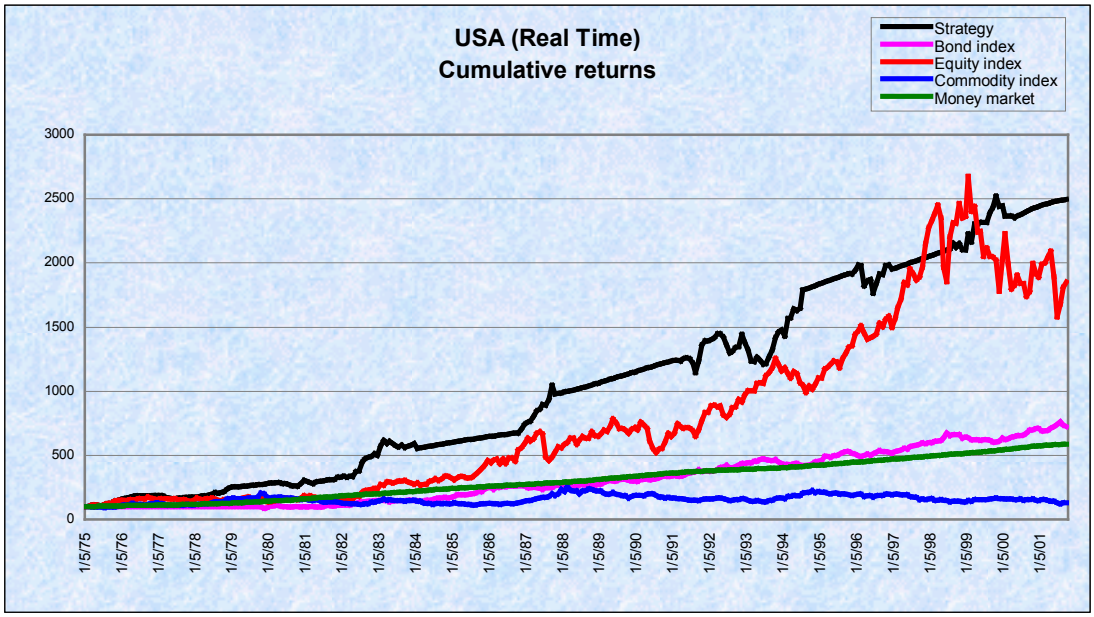
5.3 Real-time analysis for the United States (GDP based)

The presentation of the results follows the structure of the previous section, apart from sensitivity analysis parts.



The analysis starts in May of 1975 and the investment phases are:

Investment Phases									
Start date	Asset	Start date	Asset	Start date	Asset	Start date	Asset	Start date	Asset
5/1975	**Equit.**	5/1978	**Com.**	8/1981	**Money**	2/1987	**Com.**	11/1994	**Money**
2/1976	**Com.**	5/1979	**Money**	2/1982	**Bonds**	2/1988	**Money**	2/1996	**Com.**
8/1976	**Money**	8/1980	**Bonds**	5/1982	**Equit.**	5/1991	**Bonds**	5/1997	**Money**
5/1977	**Com.**	11/1980	**Equit.**	5/1983	**Com.**	8/1991	**Equit.**	11/1998	**Com.**
2/1978	**Money**	5/1981	**Com.**	5/1984	**Money**	2/1992	**Com.**	8/2000	**Money**



Sharpe ratios	**Strategy**	**Bonds**	**Equities**	**Commod.**
	0,163136	**0,088263**	**0,092937**	**-0,096186**

We finish the presentation of the results with a surprise. Strategy not only outperforms the other assets, but also has the highest Sharpe ratio observed in every analysis. This at first may seem strange: why does strategy appear a much better Sharpe ratio than in ex-post analysis? The difference is partly explained if we take into account that, under real-time analysis, phases identification suggested equities for longer periods and during these periods equities performed well enough to raise Sharpe ratio to the observed level.

We note here that even this is a real-time analysis phases identification has been performed ex-post when the whole picture of growth had been formed. This fact limits the practical usefulness of investment clock.

8. CONCLUSION

The business cycle outlines the evolution of the economy through time and provides the fundamental framework for investment returns. Nevertheless, there is little practical information on investment around the business cycle. We tried to shed more light to investment timing by examining the investment clock presented in the Economist's article.

We found that Economist's investment clock, although may seem crude at a first look, hides interesting practical information. Although it says nothing about the size of future asset-price movements, it may help understand their timing and may prove useful for long-term investors.

Ex-post analysis, GDP based showed that the investment clock would outperform the other assets if implemented in US, in Canada and in Germany, but would fail in Japan, UK, France and Italy. Ex-post analysis (industrial production based) in the US, intending to capture faster changing economic conditions, gave even better results for the investment strategy examined. More interesting were the results of the real-time, GDP based analysis for the US, which showed that the strategy largely outperformed the other assets, giving the highest Sharpe ratio obeserved in this work. Although real-time analysis was performed under real economic condition, the identification of phases was practically done ex-post having in front the whole picture of growth evolution.

We made the identification of the phases proposed by the investment clock based on fluctuations around zero growth rate. Another interesting approach would be, the identification of the phases around potential growth rate, dependent on negative or positive output gap. Under any approach there is much room for further empirical research on investment around the business cycle.

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