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How the U.S. Capital Markets Volatility Interacts with Economic Growth

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Aos meus queridos pai e mãe pelo apoio ao longo de toda a vida.
Á minha familia Cristina e Marta.

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ABSTRACT

Empirical finance suggests that capital markets volatility has a negative relationship with economic growth, in the United States. However, the main focus has been on the equity market volatility dynamics and less on other equally important asset classes, given their significant role in the structure of capital markets. In this thesis, I examine the leading and lagging dynamics between money markets, government debt, corporate debt and equities volatilities, in the U.S., and a real GDP growth proxy, between January, 1963 and March, 2009. I also introduce the concept of aggregate capital markets portfolio volatility, which follows the assumptions of a mean-variance portfolio calculation, and test its interaction with growth. Moreover, it is analysed the degree of explaining power of volatilities to the GDP proxy in specific time periods and also in NBER recessions, slowdowns and expansions periods. The empirical results posit that asset classes and capital markets portfolio volatilities are essentially counter-cyclical of growth, on a contemporaneous basis. However, this interaction changes significantly across decades. Finally, in recessions and slowdown periods rising volatility leads the economic cycle, but in expansions its downtrend lags the cycle.

Key words: Regression; Capital Markets Portfolio; Equity; Money Markets; Government Debt; Corporate and Financial Debt.

JEL classification: C20, E32, G10

RESUMO

Os estudos empíricos financeiros sugerem que a volatilidade dos mercados de capitais evidencia uma relação negativa com o crescimento económico, nos Estados Unidos. No entanto, o maior foco tem sido sobre a dinâmica da volatilidade do mercado de acções e menos noutras classes de activos, igualmente importantes, dada a sua relevância na estrutura do mercado de capitais. Nesta tese, examino as dinâmicas entre as volatilidades dos mercados monetários, das obrigações do tesouro, das obrigações de risco de crédito e das acções, nos E.U.A., e uma variável próxima do produto interno bruto real, entre Janeiro de 1963 e Março de 2009. Também introduzo o conceito de volatilidade de carteira agregada de mercados de capitais, que obedece aos pressupostos de cálculo de rendibilidade e risco de uma carteira de activos financeiros, e testo a respectiva interacção com o crescimento. Adicionalmente, é analisado o grau de poder explicativo de volatilidades para a variável próxima de crescimento, em periodos de tempo específicos e também em recessões decretadas pelo instituto NBER, em conjunturas de abrandamento e de expansão. Os resultados empíricos sugerem que as volatilidades das classes de activos e da carteira de mercados de capitais são essencialmente contra-cíclicas do crescimento, numa base contemporânea. No entanto, a intensidade desta relação varida de forma substancial entre as várias décadas. Finalmente, em periodos de recessão ou de abrandamento, uma tendência de subida da volatilidade lidera a evolução do cíclo económico, mas em periodos de expansão a respectiva tendência de descida segue o crescimento económico.

Palavras-chave: Regressão; Carteira de Mercados de Capitais; Acções; Mercados Monetários; Dívida Pública; Dívida de Empresas Não Financeiras e Financeiras.

Classificação JEL: C20, E32, G10

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LIST OF ABBREVIATIONS

BIG	Broad Investment Grade
BIS	Bank for International Settlements
BLUE	Best Linear Unbiased Estimators
CBOE	Chicago Board Options Exchange
CFNAI	Chicago Fed National Activity Index
CMP	Capital Markets Portfolio
COI	Coincident Indicator
DDM	Dividend Discount Model
DGX	Deutsche Bank U.S. Volatility Gamma Index
GDP	Gross Domestic Product
HAC	Heteroscedastic and Autocorrelation Consistent
IID	Independent and Identically Distributed
ISM	Institute for Supply Management
LTCM	Long Term Capital Management
MBS	Mortgage Backed-Securities
NBER	National Bureau of Economic Research
OLS	Ordinary Least Squares
PMI	Purchasing Managers Index
S&P	Standard and Poor's
US	United States
VIX	Volatility Index
WWII	World War II
YoY	Year over Year

1 INTRODUCTION

The year 2008, especially in the second half, was characterized by unusual variations in financial prices leading to a period of extreme high volatility in the global capital markets. Also recent data confirms that there were substantial negative consequences in terms of economic growth, not only in the United States but also in several other developed and emerging economies. In the case of U.S., aggregate output entered into a recession phase, with the third and fourth quarters exhibiting negative real GDP growth, lower than -5%, on quarterly annualised basis. Consumption and investment showed a significant contraction, given the historical standards.

In the recent past, Finance researchers have been more focused on the interaction between the potential predictive power of capital markets returns and output, with famous references being Fama (1981), Fischer and Merton (1984) and Barro (1990). There is a broad consensus for the leading role of financial markets because return is a forward looking variable, which incorporates expectations about future cash flows and discount rates. However, and given the example of the financial and economic turmoil that began in 2007, besides quantifying the impacts of asset classes returns, it is crucial to test until what extent fluctuations in financial volatility patterns affect the rate of economic growth. In this field, not only there is less theoretical foundation but also the majority of studies have mainly focused on the equity market volatility and its implications for economic growth.

Schwert (1989) finds that equity market volatility tends to increase dramatically during financial crises and in periods of high geopolitical uncertainty. Research, from Campbell et al. (2001), Guo (2002) and Bloom et al. (2009), show that equity returns and volatility are positively correlated with uncertainty about future cash-flows and, consequently, consumption and investment decisions should be negatively affected. Also Shim and Peter (2007), in the line of Fisher (1933), find that distressed selling in capital markets, with rising volatility, generate a feed-back mechanism that ultimately creates inertia for the economic growth.

With respect to other asset classes, research show that there is a negative correlation between the evolution of government bond returns, or interest rates, volatilities and the path of economic growth, like the findings of Gerlach at al. (2006) and of Hornstein and Uhlig (1999). Moreover, in terms of corporate bonds, Koutinis (2007) shows that credit spreads volatility rises with its level, complementing previous studies about the direct relationship between wider credit yield spreads and the probability of recessions (King et al., 2007).

This way, the aim of this thesis is to find an empirical long term relationship, in the United States, between the capital markets volatility and the economic growth, considering other important asset classes, besides equities, like money markets, government debt and corporate and financial debt. Not only interactions between individual asset class volatility and the rate of growth of the economy have to be tested but also the U.S. capital markets volatility, at an aggregate level, should be considered for explanatory power of growth. It is also fundamental to find if there is a persistence of a leading (or lagging) characteristic of volatility in its predictive characteristic of economic growth, at each asset class level and for the U.S. capital markets as a whole. Finally, it matters to investigate which are the potential changes in these dynamics when different time periods (e.g. decades) and economic regimes (official recessions, slowdowns and expansions) are explicitly considered in the empirical analysis.

The empirical results show that individual asset classes and capital markets volatilities are essentially counter-cyclical of growth, on a contemporaneous basis. However, this interaction changes significantly when specific sub-samples are considered. Furthermore, in recessions and slowdown periods rising volatility leads the economic cycle, but in expansions its downward trend lags the cycle. Finally, results also show that capital markets volatility, at the aggregate level, have better explanatory power, than any individual asset class, on the U.S. economic growth, not only for the entire period of the analysis but also in periods of economic recessions, slowdowns and expansions.

The remaining sections are organised as follows: Section 2 reviews the theoretical foundations on the existing literature of business and capital markets cycles, capital markets and economic growth dynamics, asset price volatility and the relationship between volatility and economic growth. Section 3 describes the methodology behind the empirical study, namely, the GDP proxies, the U.S. capital markets portfolio proxy, the volatility measures and the statistical and econometric models. Section 4 encompasses all the results from the empirical research. Finally, in Section 5 the conclusions for the entire thesis are presented.

2 THEORETICAL BACKGROUND

2.1 THE ROLE OF THE FINANCIAL SYSTEM

According to Danthine and Donaldson (2005), the financial system is a set of institutions and markets that permits the exchange of contracts and the provision of services with the primary function of allowing the income and consumption streams of economic agents to be desynchronized, in a time and risk dimensions. These functions are performed via intermediated channels, like financial intermediaries (e.g. banks) and non-intermediated channels, like the capital markets (e.g. equity and bond markets). This way, the overall financial system is composed by financial intermediaries and capital markets.

Agents have the universal desire for a smooth consumption stream, but there is not a match between consumption and investment across time. Not only is income received at discrete times while consumption is continuous, but also there are the life-cycle patterns of income generation and consumption spending, which are not identical. Furthermore, some agents are willing to accept a smaller income for a period of time in exchange for potential higher returns, and consequently income, in the future. This latter example is important for the economic growth process because although these agents do not have enough capital (or assets) to finance their projects, they need to raise it by borrowing or selling financial assets.

Capital markets allow agents to insure, diversify and hedge their risks and to redistribute purchasing power across states of nature. Additionally, because time implies uncertainty it also implies asymmetric information between individuals. Because they have access to different types and levels of information, efficient capital markets also permits them to have access to a range of products and contractual arrangements, providing the adequate information and thereby contributing to the channelling of savings to borrowers with the higher potential economic projects.

2.2 BUSINESS CYCLES

According to Burns and Mitchell (1946), business or economic growth cycles are a type of fluctuation found in the aggregate economic activity of nations that organize their work mainly in business enterprises. A cycle consists of expansions occurring at about the same time in many economic activities, followed by similarly general recessions, contractions, and revivals which merge into the expansion phase of the next cycle. This sequence of changes is recurrent but not periodic and its duration (that includes the length of recovery and recession phases) is at minimum one year, different from seasonal fluctuations.

Another definition of business cycle, from the National Bureau of Economic Research (NBER) (2008), consists of a pronounced deviation around the trend economic growth rate of change and portrays periods of accelerating and decelerating rates of growth in the economy. Usually these are closely tied to inflation cycles, that is, on average directional swings in the growth rate of the economy lead swings in the inflation rate. Cycles exist throughout many aspects of business activity, some of them are of short duration, such as the inventory cycles, whereas other cycles, as those tied to demographic issues, unfold over longer periods of time. The specific nature of the activity determines the duration of the cycle.

2.3 CAPITAL MARKETS CYCLES

Theories of financial and capital markets cycles encompass two mainly perspectives: the credit cycle (supply and demand for funds) and the monetary and interest rate cycle (a combination of monetary policy, demand for funds and growth and inflation expectations). In the first case, the main question is: does bank credit fluctuation changes the course of the business cycle? According to several authors (Burns, 1969; Minsky, 1982; Mullineux, 1990) as interest rates rise, relatively secure borrowers, who are unable to pay higher borrowing, curtail their intentions of borrowing funds from the banks. Moreover, those agents still willing to borrow at a higher cost are less creditworthy and riskier for banks. Consequently, either financial institutions assume more risk, augmenting the banking sector systematic risk, or restrict credit concession to the economy. Also, banks can become overexposed to other sectors of the economy, that are contemporaneously performing well, but when conditions in those sectors turn the banking system will be faced with mounting bad debt, and consequently the financial cycle enters into a contraction.

With regard to the monetary and interest rate cycle, according to the *Financial Accelerator Theory* (Bernanke et al., 1999), conventional monetary policy decisions, taken by central banks, of changing target interest rates are a powerful mechanism to influence the financial and capital markets cycles. This way, in order to avoid inflation growth rate above desired levels, a central bank may undergo a monetary tightening policy cycle by changing upwards the level of short-term interest rates until the economic growth stabilizes in levels consistent with the desired inflation rate. Similarly, if the economy is in its slowdown phase, given a subdued inflation scenario, the monetary authority may implement expansionary policy decisions by cutting interest rates to a level that is consistent with the target nominal economic growth. In both cases, all the different term structures of interest rates, related to different credit risks, should react accordingly going upwards, in a tightening cycle, or downwards, in an easing cycle, and ultimately will affect financial assets prices.

The *Financial Accelerator Theory* could be better exemplified considering the most common valuation process of financial assets. Based on the *Dividend Discount Model* (*DDM*) approach, it consists of calculating the present value of the expected future cash-flows of a financial asset discounted at a particular rate, that should be equivalent to the risk-free rate increased by a certain amount π, given the uncertainty associated the future cash-flow payment,

$$\sum_{t=1}^{T} \frac{CF_t}{(1 + r_t^f + \pi)^t} \tag{1}$$

Where

CF_t is the random cash-flow occurring in period t

t is the parameter of future dates (= 0, 1, 2,...,T)

$r^f{}_t$ is the risk free interest rate prevailing between date 0 and t

π is the risk premium associated with risk-bearing remuneration

Hence changes in the discount rate of the dividend stream, as consequence of changing central bank rates, will have an impact on the value of the asset and considering all the second order financial effects that may arise, consequently, leads the financial accelerator to provoke a reversal in the capital markets cycle.

2.4 CAPITAL MARKETS AND THE BUSINESS CYCLE

According to Levine and Zervos (1996) equity market liquidity, as measured by the value of securities trading relative to the size of the market or to the size of the economy, is positively and significantly correlated with current and future rates of growth, capital accumulation and productivity growth. Hence, equity and bond markets development, or the ability to trade ownership of the economy productive technologies, facilitates long run investment in higher return projects, which in turn will allow more efficient resource allocation and better physical capital formation, boosting economic growth. Similarly, Devereux and Smith (1994) argue that greater international capital market integration will augment cross-border risk-sharing and consequently will induce portfolio shifts from safe and low-return investments to riskier and high return ones, thereby accelerating long-run growth.

Niemira and Klein (1994) argue that in the traditional models, like the *DDM*, asset prices should rise because of higher expected earnings or due to a lower required rate of return used by investors to discount future earnings. This way, financial assets might fall immediately if investors lower their near-term expectations of earnings because of an expected start of contraction in the business cycle and prior to the actual fall in general economic activity. However those expectations might prove erroneous and capital markets could send false signals about future economic prospects. In the same way, a rise in the discount rate applied to future earnings could also lead to a fall in securities prices due to a lower present value of those expected cash-flows. This pattern would be followed by an economic downturn if the source of the rise in the interest rate would also provoke a slowdown in growth. In both situations, capital markets would act as a leading indicator of business fluctuations.

Also, according to Pearce (1983), the reasons why the capital markets, namely the equity market, are a leading indicator of the business cycle come from the direct effects they should have on aggregate domestic private spending, more specifically, on both consumption spending by households and investment spending by firms. His model for the United States suggests that real output, consumption and investment would substantially be less if the equity market had not risen, in the period of 1982-1983, in the aftermath of the economic recession.

2.5 CAPITAL MARKETS AND CONSUMPTION

The main channel by which financial asset prices should influence consumer spending is via the relationship with wealth. According to Ando and Modigliani (1963), in *The Life-Cycle Theory of Saving*, consumers project their resources over their expected lifetimes and decide on the consumption flows that best suit their preferences, with the constraint that the present value of their planned consumption over the years must equal the present value of their expected incomes. Part of those incomes comes from their holdings in financial assets with the remainder coming from their expected labour incomes. Because the present value of future income from assets should equal their market price, household wealth has to be an important factor of current consumption spending. Friedman (1957) in *The Permanent Income Hypothesis* argues that any shocks to income, transitory or permanent will be consumed over the lifetime of the consumer, since they prefer a smoother profile than an erratic one. However, more recently Lettau and Ludvigson (2004) only confirm that aggregate consumption, in the U.S., is well described as being a function of trends in wealth and dominated by permanent shocks. According to their research, transitory shocks in net worth, that constitute the vast majority of fluctuations, are found to be unrelated to aggregate consumer spending. Also, the so-called marginal propensity to consume, which measures by how much the value of consumption is expected to rise given a unit increase in wealth, has been object of several debates amongst analysts. According to Ando and Modigliani (1963) a unit increase in the net wealth of U.S. households would increase the consumption level by 4%, every year. Similarly, Millard and Power (2004) assume that the expected marginal propensity to consume should be very similar to the real interest rate, and in the case of the United States it should be between 3% and 5%. However, Shirvani and Wilbraite (2000) find that consumption, in several major countries (including the U.S.), respond more strongly to equity price declines than to increases, and indicate that equity markets are more importantly in recession periods.

A final issue concerns the existence of a causal connection between financial asset prices movements and changes in consumption. Otoo (1999) finds consistent results of consumers using movements in equity prices as leading indicators of future economic activity and potential labour income growth. Indeed, capital markets serve also as a barometer of consumer confidence and perhaps the financial assets price-consumption association might merely reflect the influence of greater confidence rather than greater wealth as implied by the life-cycle model.

2.6 CAPITAL MARKETS AND INVESTMENT

Fluctuations in equities and corporate bond prices are also thought to influence the level of investment spending by firms. Although the empirical significance of the relationship between equity prices and aggregate investment has not been resolved, several studies find movements in share prices with explanatory power of business fixed investment. According to Engle and Foley (1975), a 10% rise in equity prices lead, in the long run, to 8% increase in equipment expenditures and 20% rise in structures investment, after controlling for short-run share prices fluctuations and other economic variables. Caballero (1999) states that the short-run response of investment to changes in the cost of capital is complex, but nevertheless concludes that there is an important long-run relationship between capital, output and the cost of capital. More recently, Millard and Power (2004) find that investment will always respond to movements in financial assets prices irrespective of the source of the shock, whether it comes from a risk premium shock or an interest rate (risk-free) shock.

There are two main theoretical views of how capital markets and investment decisions interact: the *Market-Valuation model* or *Tobin´s q* approach and the *Cost-of-Capital approach*. In both cases, the rationale behind is that managers seek to maximize the value of their firms when making investment decisions. In the market-valuation view, firm managers acting in the interests of shareholders should only buy new equipment when the market value of the firm is expected to rise more than the cost of the additional physical capital. Tobin (1969) formalized this approach by postulating that aggregate investment is positively correlated with the ratio of total market value of firms to the replacement cost of their stock of capital. This ratio is better known as *Tobin´s q*. At its simplest, when the market value of an additional unit of capital exceeds its replacement cost, a firm can increase profits by investing. The replacement cost is the cost of replacing existing capital stock at current prices.

In the *Cost-of-Capital or Neoclassical Model* (Jorgenson, 1963), firms decide first on the desired stock of capital based on their own expected sales and costs associated to labour and capital services. Firms should also consider the price of new equipment and the financial cost of funds. Consideration of this last factor is where equity prices and corporate bond yield appear. The financial cost of capital is measured by a weighted average of the cost of bond finance and equity finance, with the weights reflecting the proportions of the firm’s assets financed by debt and equity. The cost of equity finance is the real rate of return required by shareholders, usually measured by the earnings yield ratio of corporate earnings to equity prices. A rise in equity prices with no increase in earnings reflects a lower required rate of return, a lower cost of finance and hence a lower user cost of capital. Consequently, this lower cost should, in turn, encourage firms to acquire more physical capital and increase investment.

2.7 ASSET PRICE VOLATILITY

Equation (1), which can be applied to all financial assets given appropriate adjustments, summarizes the variables that influence the price and therefore its volatility. Overall, volatility arises from uncertainty over future cash-flows and the discount rate, and an increase in volatility can only result from an increase in the variance of cash-flows shocks, an increase in the variance of discount rate shocks or an increase in the covariance between those two types of shocks.

At the macro level, cash flows for equities can be approximated by GDP, so that changes in the output volatility, everything else being equal, translate into changes in equity volatility. Uncertainty over economic conditions also affects the variables in the denominator, that is, real interest rates, expected inflation and the risk premium. According to Hamilton and Lin (1996), GDP volatility is relatively high during recessions and high financial volatility tends to be associated with weak economic conditions. Cochrane (2005) shows that volatility is also related to fluctuations in risk aversion, as investors tend to be more risk averse during recession periods, which makes volatility countercyclical. Another macro factor (Bank for International Settlements (BIS), 2006) is the monetary policy decisions that affect volatility via its impact on real interest rates, inflation expectations and on the general pace of economic activity.

The firm-specific factors or idiosyncratic component also determine the behaviour of volatility. Two characteristics of firms have been found to be critical. First, volatility is positively related to financial leverage and, secondly, is negatively correlated with the profitability of companies and positively with the uncertainty of the firm profitability (Wei and Zhang, 2006). The effect of leverage and profitability predicts countercyclical variations in volatility, because recessions are associated with higher debt/equity ratios and lower earnings. When leverage increases equity holders bear a greater share in the total cash flow risk of the firm and the volatility of equity returns increases accordingly. Also, according to Campbell et al. (2001), there has been a rising trend and increased importance over the past several decades of idiosyncratic volatility. In corporate governance there has been a strong bias to break up conglomerates and replace them with more specialized companies. Since this is a shift towards reliance on external as opposed to internal capital markets, it implies that firms are separately listed and their idiosyncratic risks are also individually measured, whereas previously they were traded as a single conglomerate that was itself a diversified portfolio of activities.

Volatility is also affected by the structure of financial markets. According to BIS (2006), important factors are market liquidity and integration, financial innovation and the degree of willingness of different type of investors to bear risk. The significant growth in risk transfer instruments may indirectly enhance markets liquidity and reduce volatility, in that allows investors to take or unwind exposures in a short period of time without having to trade in the underlying securities market. In the same way, the opening of new derivatives markets should have affected the availability of information about financial assets future cash flows. Options contracts can complete an otherwise incomplete market and can have a significant impact on the price behaviour of the underlying securities. However empirical studies find this effect ambiguous. The normal presumption is that derivatives markets increase available information and hence reduce volatility but, according to Stein (1987), it is possible for new derivatives markets to change the patterns of trading the underlying securities in such a way that the information content of prices is reduced and, consequently volatility is increased.

The evolving role of different types of investors, in recent years, should also have contributed to the behaviour of asset price volatility. Firstly, volatility may be reduced by the rise in the fraction of securities controlled by informed agents holding well diversified portfolios. Their role of superior information and rationality in stabilising financial markets is confirmed by evidence on daily volatility (Amrov et al., 2006). However price variability may be exacerbated in the short term by the investment decisions of asset managers if these are based either directly or indirectly on the decisions of others, like positive feedback trading or herding behaviour. These effects may be worsened in bad times by the presence of large players (Pritsker, 2005). In the same vein, according to several authors (Campbell et al., 2001; Gompers and Metrick, 1999), institutional investors, notably pension funds and mutual funds, form a relatively homogeneous group whose sentiment may be influenced by a few common factors, suggesting that shocks to institutional sentiment might be important in explaining the increased idiosyncratic volatility of equity returns. Malkiel and Xu (1999) explore such effect, in a sample of S&P500 securities, and find that the proportion of institutional ownership is correlated with volatility. Finally, based on the information from BIS (2006), between 1995 and 2005, hedge funds are thought to have more than doubled their size in terms of assets under management. Because these market players tend to trade more frequently it is quite possible that their actions, like increased selling in falling markets, can also potentially raise the level of volatility (Rajan, 2006).

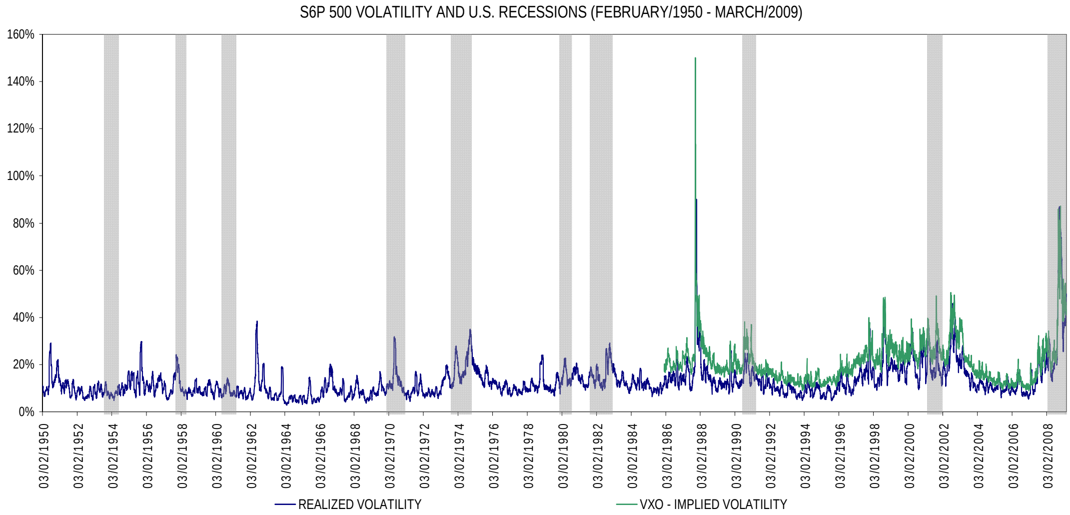
2.8 ASSET PRICE VOLATILITY AND ECONOMIC GROWTH

Several empirical studies confirm that equity markets volatility increases during recessions and decreases in periods of economic expansion, in the United States. Schwert (1989) finds that equity market volatility tends to increase dramatically during financial crises (such as the 1987 U.S. equity market crash, the 1997 East Asia crisis, the 1998 Russian bond default) and periods of high geopolitical uncertainty (like the 1962 Cuban missile crisis). Moreover, volatility once have risen shows some inertia because it reverts slowly to the previous low level. Empirical analysis confirms the theoretical assumption that asset price volatility is countercyclical of economic growth because of expectations of cyclical variations in the volatility of fundamental variables. That, in turn, affects the variance of financial assets future cash-flows, the risk-free rates and the equity or credit risk premium inherent to the financial asset. Guo (2002) posits that a positive shock in equity market volatility may reduce future economic growth, because it reflects uncertainty about future cash flows and discount rates, hence providing important information about future economic activity. According to Campbell et al. (2001) capital markets volatility is related to a structural change in the economy. Structural changes consume resources, which depresses gross domestic product growth. Similarly, if an increase in capital markets volatility raises the compensation that equity and bond holders demand for bearing systematic risk, than the expected higher return leads to higher cost of finance of capital and debt in the corporate sector which will negatively affect investment and output. In the same vein, Bloom et al. (2009) demonstrate that modelling shocks to uncertainty, measured by equity market volatility, rising uncertainty leads to large drops in employment and investment that ultimately will lead to falls in productivity and in the business cycle. Also, Shim and Peter (2007) develop the concept of distress selling and asset market feed-back. This is a process of financial instability characterized by sequential events of distressed institutions selling assets, asset prices falling, cash-flows and balance sheets deteriorating and more assets being sold into a falling market. The fall in the asset price decreases its mean and increases its volatility, introducing a negative skewness in the ex-post price distribution. The negative economic consequences are twofold: (a) if the distressed seller is the best user of the real asset than there will be an inefficient usage of productive assets; (b) productive assets with current low prices with the possibility of even lower future prices, due to asset market feed-back, discourages investment decisions.

In the case of interest rates, Gerlach et al. (2006) find that an increase in the output gap (a rise in real GDP relative to trend) is typically negatively correlated with government bond market volatility. Their results also show that there is a contemporaneous relationship, between the change in the output gap and the volatility of bond returns, in the post-WWII period. Hornstein and Uhlig (1999) state that the standard real business cycle models predict investment to be quite elastic with respect to interest rate movements: the fluctuations in the real rate should lead to substantially larger swings in investments. Moreover, some theoretical research, like King et al. (2007), find that widening corporate credit spreads embed crucial information about probability of future economic recession, and that credit spreads changes are an increasing function of their own volatility (Kounitis, 2007).

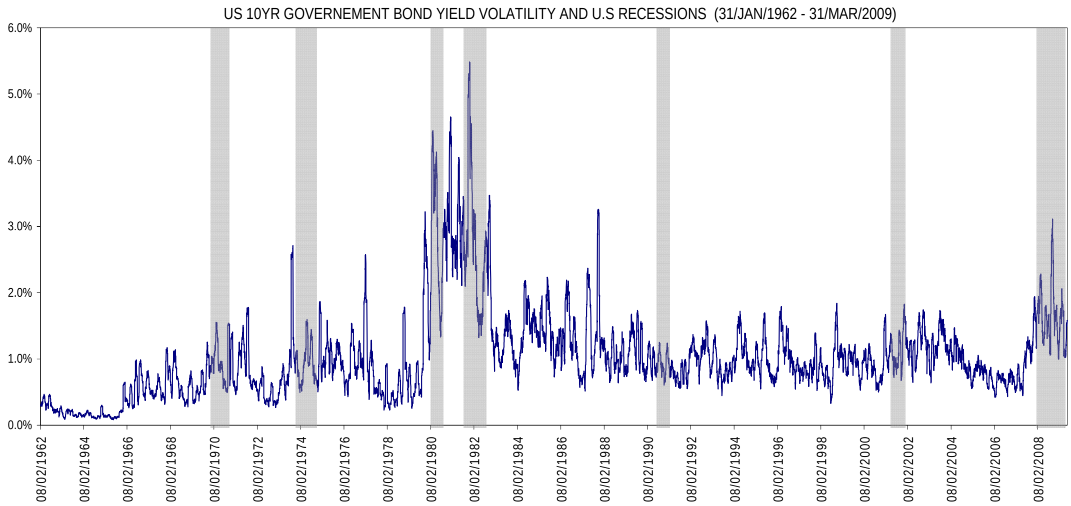
However, previous studies also suggest that it is not only the expected macroeconomic volatility and the time variation in dividends of financial assets that fully explains financial fluctuations. Campbell and Cochrane (1999) introduce the slow-moving habit concept, or time-varying subsistence level, in the consumer's utility function. The findings are that as consumption falls toward the habit, in a business cycle through, the curvature of the utility function rises, asset prices fall, expected returns rise and returns volatility also rise. Furthermore, according to Bekaert el al. (2005), the cyclical shifts in markets participants risk aversion are also an important factor. In their research, about three quarters of fluctuation in equity returns is accounted for by the expectation of variance of fundamental factors and the remaining explained by changes in risk aversion. In other words, asset price volatility is also influenced by the uncertainty of investors about macro and micro fundamentals. Since empirical findings support that the levels of uncertainty are higher when the economy is weak, this approach also confirms the countercyclical nature of financial volatility.

Figures 1 and 2 show that popular discussions of increasing capital market volatility over time is untrue. At the aggregate level the percentage volatility of market index returns shows no systematic tendency to increase over time. In general there is no discernible trend in financial markets volatility. Moreover, it is possible to see that capital markets volatility, measured by the S&P 500 returns and the 10yr government bond yield changes, increases during official recession periods.



NOTE: Realized volatility is 1 month rolling standard deviation of the S&P500 daily log returns (annualised); VXO represents the implied volatility of an hypoyhetical S&P100 option with 30 days to expiration; Shaded areas indicate recessions dated by the US National Bureau of Economic Research (NBER). SOURCE: Bloomberg, NBER.

Figure 1: U.S. equity volatility and U.S. economic recessions (NBER)



NOTE: Realized volatility is 1 month rolling standard deviation annualised of daily observations of the generic US governement bond 10yr yield (constant maturity) first differences; Shaded areas indicate recessions dated by the US National Bureau of Economic Research (NBER). SOURCE: Bloomberg, NBER.

Figure 2: U.S. 10YR government bond yield volatility and U.S. economic recessions (NBER)

3 METHODOLOGY

3.1 U.S. ECONOMIC GROWTH PROXIES

Firstly, in order to investigate the interaction between low frequency data, like real GDP growth released on a quarterly basis, and financial volatility, available on a daily basis, it is imperative to consider a GDP proxy of a higher frequency than quarterly publications. It should be at best released on a monthly frequency. The reason is that by using only quarterly information of financial volatility, to investigate the dynamics with growth, it would increase the probability of losing important information about the change in patterns of variability in asset returns. At the same time, and for not incurring in lost of accuracy it is needed to consider a proxy that almost replicates the GDP growth.

I considered three main indicators that could serve as good proxy. The objective was to find a type of data that not only encompasses the broader economic activity but also is coincident with the real GDP number and tracks different business cycles. The first indicator was the Chicago Fed National Activity Index (CFNAI), released by the Federal Reserve Bank of Chicago on a monthly basis. It is a weighted average of 85 indicators of U.S. economic activity from four categories of data: 1) production and income; 2) employment, unemployment and hours; 3) personal consumption and housing; and 4) sales, orders and inventories. All these data series measure some aspect of overall macroeconomic activity. Consequently, the derived index provides a single summary measure of a factor common to the U.S. economic data. Each month, the index number reflects economic activity in the latest month.

The second measure considered was the Purchasing Managers Index (PMI), published by The Institute for Supply Management, also on a monthly basis. The survey is done among 40,000 members engaged in the supply management and purchasing activities. It is a composite index of five sub-indicators, which are extracted through surveys on purchasing managers from around the United States, chosen for their geographic and industry importance. The five sub-indexes are production, new orders from customers, supplier deliveries, inventories and employment level. The PMI is a crucial sentiment reading, not only for manufacturing, but also for the overall economy. Although U.S. manufacturing is not the huge component of total gross domestic product, the industry sector is where recessions tend to begin and end. Moreover, its strengths arise from the timely release, always coming out on the first day of the month following the survey month and from being a good predictor of future GDP releases.

Thirdly, the Composite Index of Coincident Indicators (COI), monthly released by the Conference Board, was originally developed by the NBER as making part of a set of business cycle indicators with the objective of tracking business cycles. The Composite Index comprises four cyclical economic data sets. The components were chosen because they exhibit strong correlation with the current economic cycle. The Conference Board considers the coincident components of a broad series that measures aggregate economic activity and thus the business cycle. The four components are: 1) employees on non-agricultural payrolls; 2) personal income less transfer payments; 3) index of industrial production and 4) manufacturing and trade sales. Historically, the cyclical turning points in COI have occurred at about the same time as those in aggregate economic activity.

3.1.1 *Proxies Correlation with U.S. Real GDP*

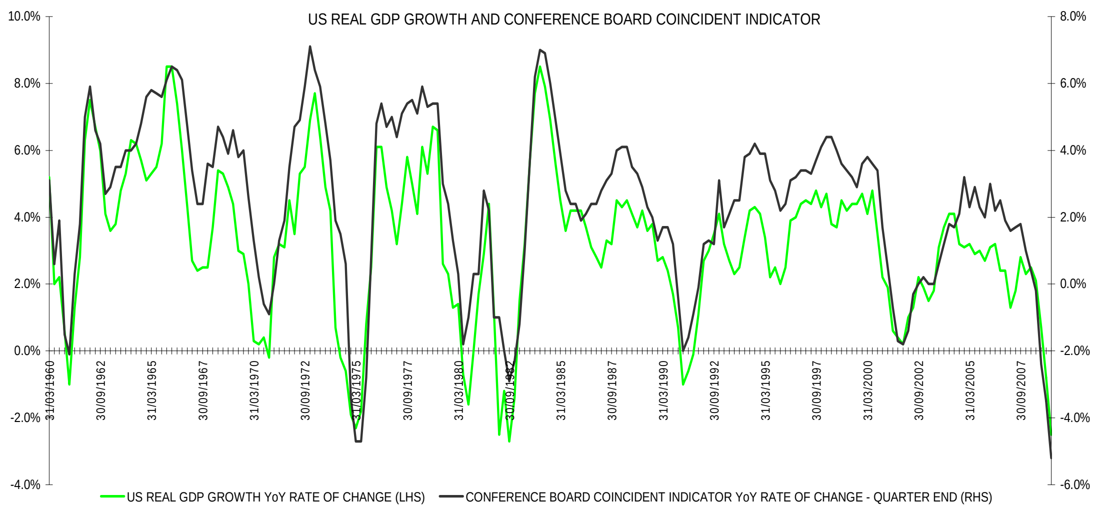
In order to find if the economic indicators described above were able to be considered proxies for the year-over-year growth rate of U.S. real GDP, I ran standard OLS regressions (using EVIEWS software) between those proxies (independent variables) and the growth rate of the real GDP aggregate measure (dependent variable), using quarterly data, which corresponds to the GDP release frequency. Results are in Table 1. Three different types of metrics were considered for the explanatory variables: the quarter end level, the average quarter level and the year-over-year growth rate at the end of the quarter. If the monthly indicators are true proxy candidates for GDP, not only must they exhibit significant correlation with growth but also the strongest fit must be contemporaneous and not too much leading or lagging of GDP. Consequently, for the three metrics of the indexes a contemporaneous regression and another with one quarter lag were run in order to measure the statistical significance. As the data samples were equal for the proxy candidates, and due to the different times each indicator started to be released, the smallest time horizon started in March 31, 1967, for the CFNAI. All regressions were performed until March 31, 2009. Given the quarterly data frequency considered, and also that the smallest data sample consists of 169 observations, it is reasonable to conclude that the number of observations is enough to interpret the regression results with some degree of confidence. Heteroscedastic and autocorrelation consistent (HAC) Newey-West coefficients standard errors estimates were computed for all the regressions. The results point that all the estimated coefficients are significant at 1% level, with the exception of the CFNAI year-over-year rate of change. The indicator, for which the regression results are statistically more significant, is COI. It has a higher coefficient of determination, compared to ISM and CFNAI, when the quarter end level and year-over-year rate of change metrics are considered, contemporaneously and lagged one quarter. Only when one lag in the average quarter level metric is considered, the R^2 is slightly lower than the ones corresponding to ISM and CFNAI. Given the relative results obtained, COI seems to be the best economic indicator in explaining U.S. GDP rate of growth variability. But for COI to be considered a good growth proxy it must have a strong R^2 value. The results obtained, in Table 1, show that the year-over-year metric for this indicator is high and also its absolute level, above 0.80, makes it possible to consider COI YoY as a proxy, with a monthly frequency release, for GDP growth YoY, which is quarterly released. Furthermore, in order to check if these selected indicators were contemporaneous with growth, cross correlations were computed, with maximum 36 lags, to find if correlation could be higher between observations of GDP and proxy candidates in different points in time. In Appendix 1 those results are shown, proving that the above relationship is essentially contemporaneous, with higher correlation coefficients as leads and lags tend to zero. In the case of COI, the highest correlation occurs when lag 0 is applied, but for ISM and CFNAI the same highest level occurs in lag 1 against GDP. This way, the cross correlations analysis gives additional support to COI YoY, as the most robust and contemporaneous proxy indicator. In Figure 3, it is shown the high degree of correlation between the two variables. Not only persists in periods of growth acceleration but also in times where the economy enters in slowdown or recession periods.

TABLE 1

U.S. REAL GDP PROXIES

R- SQUARED FROM LINEAR REGRESSION WITH US REAL GDP GROWTH YoY			
	PROXIES FOR GDP GROWTH		
PROXIES MEASURES	COINCIDENT INDICATOR	PURCHASING MANAGERS INDEX	CHICAGO FED NATIONAL ACTIVITY INDEX
QUARTER END LEVEL	0.83	0.42	0.36
QUARTER END LEVEL -1	0.62	0.59	0.56
AVERAGE QUARTER LEVEL	0.81	0.51	0.55
AVERAGE QUARTER LEVEL -1	0.50	0.60	0.68
YEAR-OVER-YEAR CHANGE	0.82	0.27	0.05 **
YEAR-OVER-YEAR CHANGE -1	0.62	0.35	0.29

Note: This table reports R-squared from OLS regressions between different measures of US economic growth proxies (independent variables) and US Real GDP Growth (dependent variable). Regressions are based on quarterly raw data available for each indicator. -1 represents one observation lag. Newey-West Standard Errors are computed. All the estimated coefficients are significant at 1% level, with the exception of **. All ending in the 1ºQ 2009. Real GDP Growth from the Bureau of Economic Analysis begins in Feb/50. The Conference Board-Composite Index of Coincident Indicators begins in Jan/1959. The Purchasing Managers Index from the Institute for Supply Management Index begins in Jan/50. The Chicago Fed National Activity Index from the Federal Reserve Bank of Chicago begins in Mar/67. Source:Bloomberg.



NOTE: Quarter end observations between March 1960 and March 2009; Data are coincident. Source: Bloomberg.

Figure 3: Coincident Indicator and real GDP growth

3.2 U.S. CAPITAL MARKETS

Given that the U.S. capital markets have developed significantly in the last decades, in terms of its size and financial instruments complexity, I considered in the analysis the asset classes that are the bulk of the U.S. capital market constituents and for which there is data available for an extended time span: equities, government debt, corporate and financial debt. Although having in mind that capital markets, according to Mishkin (1998), are the markets in which longer-term debt (maturity of one year or greater) and equity instruments are traded, I also decided to include in the analysis the money markets class, considering its crucial role for the economy.

In terms of the benchmarks selected, for the equity market I considered the S&P 500, which constitutes a good proxy given the significant number of its constituents, the ample liquidity and the fact of being the underlying index for many derivatives instruments and benchmark for financial assets portfolios managed on an international scale. Additionally, it is also a good proxy for the structure of the U.S. economy because its 500 company members are ranked by market-capitalisation. Finally, it has an historical record that is as longer as the one available for COI.

In the case of government debt, I considered the yield of the 10 years constant maturity government bond benchmark. Typically the main maturity benchmarks considered by market investors are 2yr, 5yr, 10yr and 30yr. The reasons to choose the 10yr bond for the proxy of the government debt market are: (1) the data available for the 10yr bucket is the longest one; (2) the 5yr maturity is highly correlated with the 10yr so there is no great loss of additional information; (3) the 30yr benchmark is a less traded point of the US yield curve, highly influenced by supply and demand issues; and (4) the 2yr, in spite of being a better reflection of short-term interest rates expectations than the longer maturities, is replaced by other proxy for short-term rates, the 3-month constant maturity yield, in the money market class. Since one of the purposes of this study is to measure financial volatility, I only took into account the effects of yield changes in the price of a 10yr bond index, given a constant modified duration risk parameter. The convexity effect, being marginal in bullet fixed rate bonds, was not considered in the price changes function of yield changes. Given the constant maturity of 10yr yield, I also assumed a fixed modified duration of 8.20. This parameter was a function of the average of modified duration levels between the benchmark bond and the first off-the-run bond, in the 10yr bucket, as of July 31, 2009. For the volatility analysis, I did not include coupon gains in the return of this asset class, since the volatility source in fixed coupon government bonds only arises from its market value changes due to yield changes and not from the accrued component of the gross price.

In the corporate and financial debt class, that encompasses corporate and financial credit risk issuers, I used the Average Rating Moody's Corporate Yield Index. Not only there is historical data available for the time dimension considered in the analysis but also the average rating index is a better proxy for the U.S. overall credit risk, compromising both investment grade and high yield markets and also the entire maturity spectrum of the credit market. The methodology, in terms of risk parameters considered, was the same as in government bonds. I developed an index which changes are only function of yield movements, given a modified duration assumption for the relationship between yield and price. I assumed an estimate of 6.05 for modified duration, based on the following principle: given that the maturity of the Moody's index is not constant over time, I calculated an average of the historical monthly observations of modified duration (Bloomberg data) from Citigroup U.S. BIG Credit Benchmark Index, available since December 31, 1979. Its yield historical behaviour is highly correlated with Moody's index yield and the rating is also similar to the Moody's one, both reflecting U.S credit market conditions at any point in time (Citigroup, 2009).

Finally, the money markets class (short-term debt up to one year maturity) volatility was calculated based on the 3-month constant maturity treasury-bill benchmark. I assumed an index capitalised at the prevailing 3-month rate in the beginning of each month. No modified duration assumptions were made given the constant residual maturity of the benchmark treasury-bill. Moreover data on this financial instrument is available on a long time horizon.

Furthermore, I have developed a U.S. capital markets portfolio proxy (CMP) comprised of equities, government debt, corporate and financial debt and money markets. Based on information available from Standard and Poor's (2007), about the equity market capitalisation, and from BIS (2009), about the different types of debt outstanding by U.S. domestic issuers, both in US$, I considered different weightings since 1989, according to the quarterly information available. Figure 4 shows the average weightings of each asset class between 1989 and 2008, with equities and corporate and financial debt reaching 70% (35% each) of CMP. Government debt represents 18% and the short-term debt the remaining 12% of CMP. Figure 5 represents the historical evolution of percentages in each asset class and Appendix 2 includes the historical evolution in terms of US$ figures outstanding.

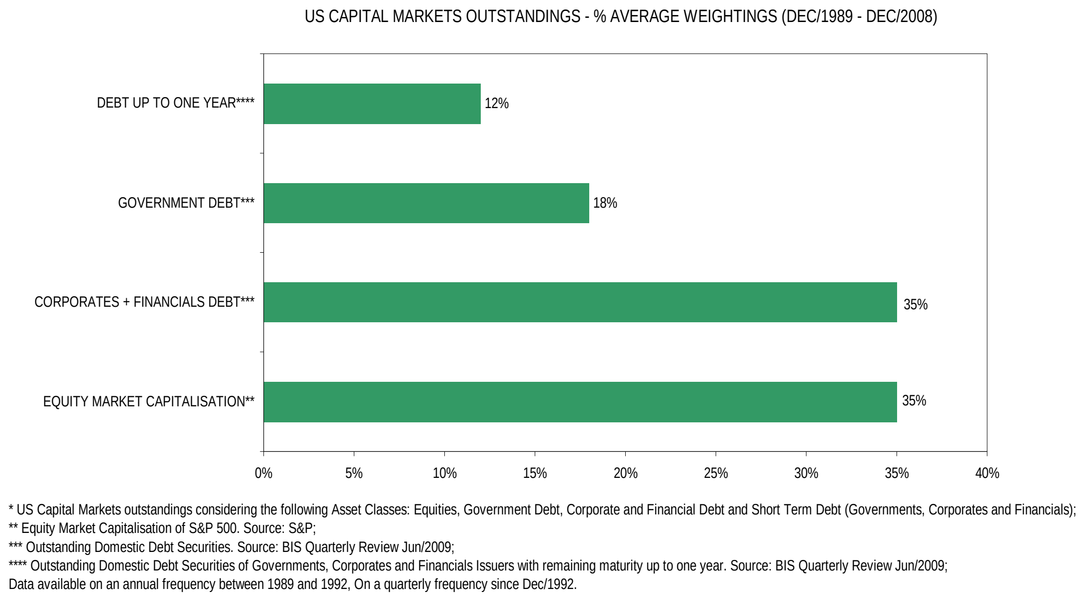


Figure 4: U.S. capital markets portfolio proxy (%) weightings

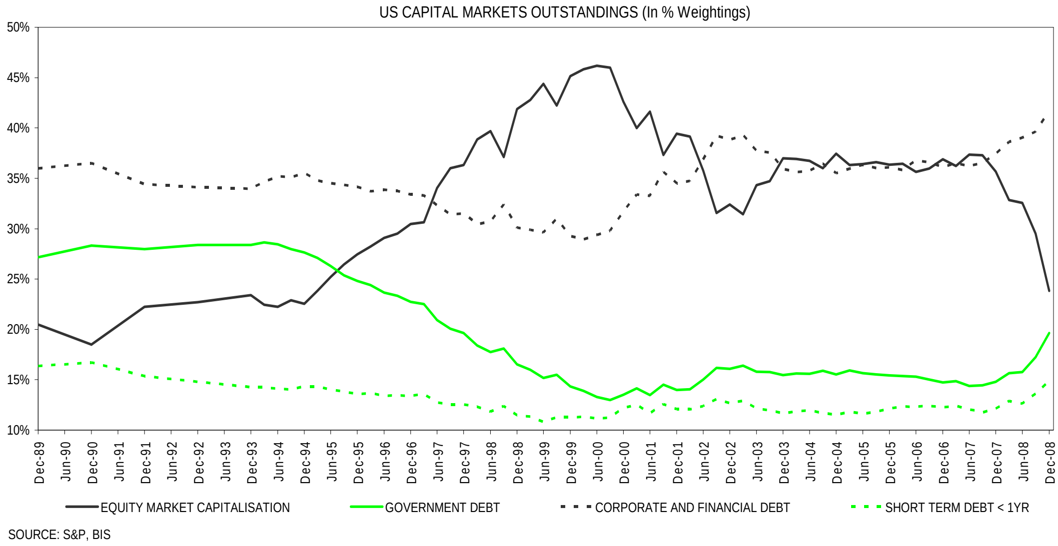


Figure 5: U.S. capital markets portfolio proxy (%) historical evolution

3.3 VOLATILITY MEASURES

Analysts and financial markets participants estimate volatility in one of two following ways.

The first one is by computing the historical financial instrument (X_t) volatility, using the standard deviation measure. Considering p_t and p_{t-1} the security prices in periods *t* and *t*-1, respectively, the variable of interest (X_t) is the compounding rate of change in price between two time periods, expressed as follows

$$X_t = 100 * [Ln(p_t / p_{t-1})] \tag{2}$$

Historical volatility calculation refers to a certain time period (e.g. daily) that can be easily transformed into any periodicity through multiplication by the square root of the number of trading days, assuming that the logarithmic changes are independent and identically distributed (IID). Also, because historical volatility always refers to a period in the past can therefore be easily calculated via the method described above. The pendant for any time frame in the future is usually referred to as realised volatility.

The second method is to estimate a financial instrument volatility using derivatives observed prices (like options). Volatility calculated using this approach is called implied volatility and it captures the expectation of financial markets about realised volatility, for any period in the future. Unlike historical volatility, implied volatility is the reflection of the realised volatility implied from *Black-Scholes* option pricing model, using the options premiums observed in the market. The underlying periodicity for implied volatility is one year, as it is expressed as volatility per annum, but also, can easily be transferred into any other time periods as mentioned above.

Since capital markets and instruments are considered forward looking variables of the state of the economy, the volatility measure to adopt in order to investigate the interaction with economic growth, could be an estimation of implied volatility. However, there are important caveats. It has to be assumed that the option pricing model is correct and this type of models usually assume that volatility is constant over the life of the option, which in turn makes more difficult to interpret an implied volatility output. Also, Ang et al. (2006) raise a concern about implied volatility measures because it combines both expected volatility and the volatility risk premium. Finally, there is only historical data available for implied volatility in some asset classes, like equities. In this case, the Chicago Board Options Exchange introduced the CBOE Volatility Index, VIX, which is the benchmark for U.S. equity market volatility, with quotes only existing from 1986. Based on options on the S&P 500, it estimates the expected volatility from prices of equity index options in a wide range of strike prices, and derives expected volatility by averaging the weighted prices of out-of-the money calls and puts.

In the case of the U.S. government bonds asset class, an index followed by market participants is the Deutsche Bank U.S. Volatility Gamma Index (DGX), which consists of weighted averages of at-the-money swaptions premiums with the underlying swap maturity ranging from 3 months to 30 years. The historical data available of this index, which begins in the 1994, is not enough to analyse the interaction of this gauges and different phases of U.S. business cycles. In addition to this, in the case of the corporate bond market it is even more difficult to find a measure of implied volatility, with a wide historical time-length and of general acceptance of market participants.

Since several asset classes are considered in the analysis (equity, government bond yields, corporate bond yields and money markets) and given the caveats of implied volatility explained above, the default measure used for all the asset classes is the historical volatility. However, empirical analysis is also done with implied volatility in the case of equities, given the constraints already exposed.

Historical volatility for equities is estimated by computing the annualised standard deviation of the last twelve months rolling natural logarithm returns.

3.3.1 *Yield Volatility*

For interest rates and yields, although there is no consensus agreement on how volatility should be defined, according to Rieger et al. (2007), market participants should use a metric of normalised volatility. The volatility measures introduced above refer to percentage changes of some underlying asset and not to absolute changes. In the fixed income camp, the volatility on percentual changes is known as yield volatility, whereas the volatility on absolute changes (Δy) is known as normalised volatility. In this analysis, I adopted the standard deviation of the absolute rate of changes instead of relative rate of changes. This choice is warranted by three observations: (a) the risks assumed by bond market investors are proportional to the volatility of absolute rate of changes since the return on a portfolio of bonds approximately equals its modified duration times the interest rate change; (b) changes in percentual yield volatility will much depend on outright yield levels and will not be considered a pure reflection of volatility related changes; (c) in the sample there could be instances of zero rates, in which case relative changes can not be defined.

3.3.2 *Capital Markets Portfolio Proxy (CMP) Volatility*

In order to calculate the impact of U.S. capital markets volatility in economic growth, considering several asset classes simultaneously, I developed the intuition of the capital markets portfolio proxy (CMP) and the diversification effects that emerge in terms of overall volatility. According to the *Modern Portfolio Theory*, whereas the expected returns on a securities portfolio is the weighted average of expected returns on the individual assets, the same is not true for variance. The volatility of a portfolio is typically less than the weighted average of the individual volatilities. This is the gain from portfolio diversification. Consequently, the smaller the correlation coefficients the greater the benefits from diversification will be.

Considering r_t as the (Nx1) vector of returns on the N asset classes in time *t*

$$r_t = \begin{pmatrix} r_{1,t} \\ \vdots \\ r_{N,t} \end{pmatrix}$$

The covariance matrix of asset class returns is defined as

$$V_t = Cov(r_{i,t}, r_{j,t}) = \begin{pmatrix} & \vdots & \\ \cdots & \sigma_{ij,t} & \cdots \\ & \vdots & \end{pmatrix}$$

The (Nx1) vector of CMP weights is

$$w_t = \begin{pmatrix} w_{1,t} \\ \vdots \\ w_{N,t} \end{pmatrix}$$

The return on CMP is

$$r_{CMP,t} = w_t' r_t \qquad (3)$$

Hence, the variance of $r_{CMP,t}$ will be given by

$$\sigma^2_{CMP,t} = Var[w_t' r_t] = w_t' V_t w_t \tag{4}$$

And volatility by

$$\sigma_{CMP,t} = \sqrt{w_t' V_t w_t} \tag{5}$$

Where

N is the number of asset classes in the CMP (Equities, Government Debt, Corporate and Financial Debt, Money Markets)

$r_{i,t}$ is the monthly log return of asset class i in month t

$\sigma_{ij,t}$ is the covariance between log return of asset class i and log return of asset class j, in month t

$w_{i,t}$ is the weight of asset class i in CMP, in month t

The volatility of CMP is calculated in line with equation (5). For each time period, month t, variance of asset class i and covariance between asset classes i and j are computed based on their last twelve months log returns. Weights in t, for the asset class i, are function of the average of the last twelve month observations, starting in December, 1989. Due to the lack of availability of BIS data, with regard to debt outstanding before this period, I considered fixed weights for the different asset classes, between January, 1963 and December, 1989.

3.4 ECONOMETRIC MODELS

To investigate the dynamics between the U.S. capital markets and COI YoY, I have estimated standard OLS regressions using EVIEWS software. Not only were tested contemporaneous relations, but also 12 leads and lags (one year gap) of volatility of the different asset classes and CMP, as the explanatory variable, against COI. I also computed cross-correlations up to 60 months (5 years) to detect long lag-lead correlations between the two variables across different business and capital markets cycles, which results, when statistically significant, are presented in Appendix.

Since heteroscedasticity is a common phenomenon in this type of statistical relationships, White´s tests were performed in every estimated model analysis, and the results were conclusive in terms of evidence of heteroscedasticity, meaning that it was not plausible to assume that the variance of the errors was constant. By the same way, I also tested whether the residual series from the estimated models were autocorrelated, via Durbin-Watson first order autocorrelation tests, and, as in the case for heteroscedasticity, the residuals from the regressions appeared to be correlated. According to Brooks (2002), the consequences of ignoring heteroscedasticity and autocorrelation of the residuals are that the OLS coefficients of the volatility variables are not the *Best Linear Unbiased Estimators* (*BLUE*), which could lead to wrong inferences made about asset class volatility being or not an important determinant of variations in U.S. economic growth. Consequently, given the presence of both residual heteroscedasticity and autocorrelation, the t-statistics of the original regressions were appropriately changed using Newey-West modified consistent standard error estimates.

For the full-sample or sub-sample periods considered

$$COI\_YoY_t = \alpha + \beta * CM\_Vol_{t+i/-i} + \mathrm{u_t} \tag{6}$$

$$COI\_YoY_t = \alpha + \beta * CM\_Vol_t + \delta * D_{t+i/-i} + \mathrm{u_t} \tag{7}$$

Where

α - Intercept parameter;

COI_YoY - Natural log year-over-year returns of Conference Board Coincident Indicator;

β - The slope coefficient of the explanatory variable;

CM_Vol - 12-month rolling historical annualised volatility of natural logarithm monthly returns of equities and of capital markets portfolio proxy, or 12-month rolling historical annualised volatility of first differences of short-term yields, long-term government bond yields, corporate and financial bond yields and corporate and financial yield spreads;

D - Dummy variable taking the value 1 or 0, to represent a particular observation either having or not a given property: NBER recession periods, uptrend and downtrend economic growth periods;

δ - Dummy variable coefficient representing a shift in the intercept of the regression line due to the presence of a given property;

ε - Gaussian variable independently and identically distributed with 0 expectation and variance σ^2;

$+i/-i$ - Monthly leads/lags, up to 12, applied to the explanatory continuous and dummy variables.

4 EMPIRICAL STUDY

4.1 DATA

The objective was to consider a vast sample enough to encompass several business cycles, different phases of expansions, slowdowns and recessions and also different stages of the capital markets. All the economic and financial data was obtained through Bloomberg Data Base System. Given that the data availability of the financial and economic variables is not the same, I have considered the beginning of the 10yr treasury yield series (the latest set of data to be available for the defined asset classes group) as the initial historical observation of the empirical analysis between U.S. financial volatility and growth. The analysis starts in January 31, 1963 and ends in March 31, 2009, which results in 555 monthly data observations. Natural logarithm returns are calculated for the GDP growth proxies and also for equities historical volatility metric. In the case of short term and long term yields and corporate bonds yield spreads, volatility is computed based on the first absolute differences.

4.2 EQUITY VOLATILITY

4.2.1 *Historical Volatility*

Besides the entire period subject to the analysis, from January, 1963 to March, 2009, regressions were also run for two distinctive periods: (a) one that begins in January 1963 and finishes in September 1987 and (b) another from October 1988 to March 2009. The main reason behind this sample partition is that the equity market crash that occurred in October 1987, with the major equity market indexes falling around 20% in one day, was a pure financial phenomenon that provoked a huge spike in levels of realized and implied volatilities. However, the financial institutions in the United States survived with very few problems and the economy did not enter into a major recession.

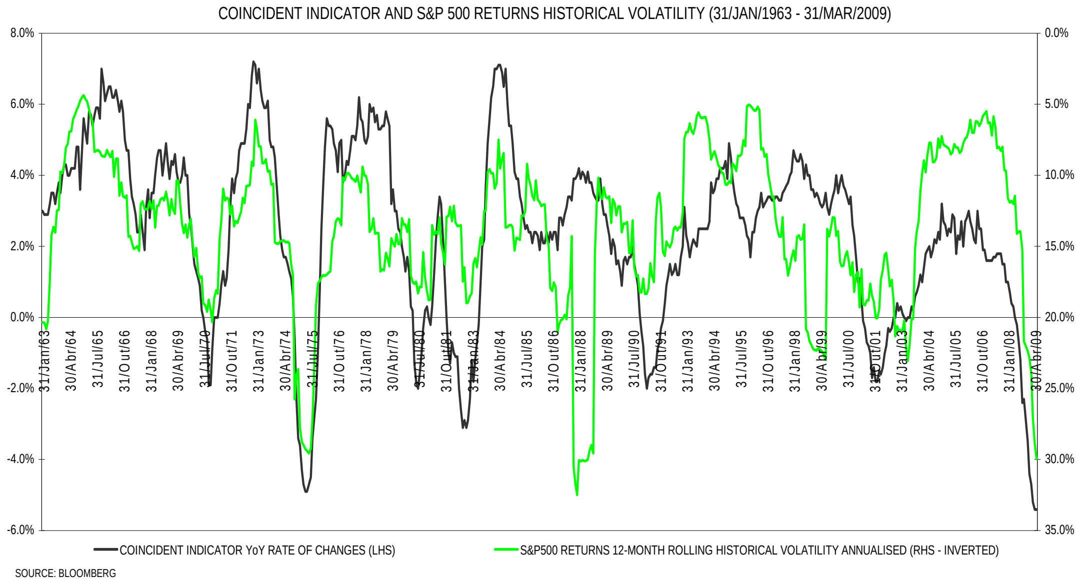


Figure 6: Coincident indicator and S&P 500 historical volatility

Given the persistence of high levels of volatility in several months following that event (Figure 6), the time period between October 1987 and September 1988 was not considered in the sample partition. Table 2 shows the OLS results for the raw data and for the two sub-samples analysed. Results show that the estimated coefficients are always negative, irrespectively of the leads and lags considered, up to 12. It is also evident that the more contemporaneous is the data, of dependent and independent variables, the R^2 and t-statistics also tend to be higher. In the three time frames considered, the contemporaneous and one lag applied to the explanatory variable generate the most significant results. It is also shown that, given the lead-lag results (with the lagging ones being more significant than the opposite leading ones), the volatility pattern shortly leads the rate of economic growth pattern. Consequently, it means that, besides the negative relationship that exists between U.S. equity volatility and economic growth, there is not a substantial time gap between higher volatility and the negative impact it has on the economic activity. However, in terms of the three samples considered, results show significant differences. The R^2 and t-statistics obtained in the January 1963 - September 1987 regressions are the highest in all leads/lags applied to volatility. In absolute terms, for that period, given a contemporaneous relationship, 44% of the variability of economic growth (COI) is explained by the variability of S&P 500 returns historical volatility.

In the period of October, 1988 to March, 2009, results obtained are not so strong, given that less than 20% of the variability of economic growth is explained by the variability of the volatility measure, when the relationship is contemporaneous or with one month volatility lag.

Furthermore, all the coefficients are statistically significant at 1% significance level in the regression based on the sample January 1963 - September 1987, when maximum 9 leads and lags are considered. In the period October 1988 - March 2009, beyond 7 lead months, estimated coefficients are not statistically significant and lead 6 is significant at 10% level. Moreover, when time lags higher than ten months are applied the estimates are statistically significant only at 10% significance level. Finally, in the regressions where the raw data is considered, only the lead and lag 12 are not statistically significant.

Thus, it is possible to conclude based, on statistical analysis, that since January, 1963 equity volatility has been counter-cyclical of economic growth with a slight leading bias. However, the relationship was much stronger between January, 1963 and September, 1987 than in the subsequent time frame until March, 2009.

TABLE 2

EQUITY HISTORICAL VOLATILITY

REGRESSION WITH US EQUITY VOLATILITY			
	TIME PERIODS		
VOLATILITY LEAD (MONTHS)	31/JAN/1963 - 30/SEP/1987	31/OCT/1988 - 31/MAR/2009	31/JAN/1963 - 31/MAR/2009
+ 12 LEAD	0.01	0.01	0.01
	-1.40 ***	***-0.76*** *	***-1.23*** *
+ 11 LEAD	0.02	0.02	0.01
	-1.84 ***	***-0.90*** *	***-1.54*** **
+ 10 LEAD	0.04	0.02	0.02
	-2.32 ***	***-1.06*** *	***-1.86*** **
+ 9 LEAD	0.07	0.03	0.04
	-2.83	***-1.18*** *	***-2.15*** ***
+ 8 LEAD	0.10	0.04	0.04
	-3.32	***-1.36*** *	***-2.38*** ***
+ 7 LEAD	0.13	0.05	0.05
	-3.85	***-1.56*** *	***-2.62***
+ 6 LEAD	0.18	0.06	0.07
	-4.41	***-1.81*** **	***-2.83***
+ 5 LEAD	0.23	0.08	0.08
	-5.05	***-2.04***	***-2.99***
+ 4 LEAD	0.28	0.10	0.11
	-5.77	***-2.27***	***-3.15***
+ 3 LEAD	0.33	0.12	0.13
	-6.55	***-2.49***	***-3.29***
+ 2 LEAD	0.37	0.14	0.15
	-7.32	***-2.70***	***-3.41***
+ 1 LEAD	0.41	0.16	0.17
	-8.12	***-2.85***	***-3.52***
CONTEMPORANEOUS	0.43	0.18	0.18
	-8.77	***-2.91***	***-3.59***
- 1 LAG	0.44	0.17	0.18
	-9.04	***-2.92***	***-3.61***
- 2 LAG	0.44	0.17	0.18
	-8.88	***-2.96***	***-3.61***
- 3 LAG	0.41	0.16	0.16
	-8.30	***-2.98***	***-3.59***
- 4 LAG	0.37	0.15	0.14
	-7.34	***-2.98***	***-3.51***
- 5 LAG	0.31	0.13	0.12
	-6.17	***-2.93***	***-3.36***
- 6 LAG	0.26	0.11	0.09
	-5.07	***-2.75***	***-3.15***
- 7 LAG	0.20	0.10	0.08
	-4.12	***-2.63***	***-2.93***
- 8 LAG	0.15	0.09	0.06
	-3.35	***-2.49*** ***	***-2.66***
- 9 LAG	0.11	0.08	0.04
	-2.73	***-2.27*** ***	***-2.37*** ***
- 10 LAG	0.07	0.07	0.03
	-2.22 ***	***-2.05*** ***	***-2.04*** ***
- 11 LAG	0.05	0.06	0.02
	-1.78 **	***-1.89*** **	***-1.72*** **
- 12 LAG	0.03	0.05	0.01
	-1.42 *	***-1.73*** **	***-1.42*** *

Note: This table reports R-squared and t-statistics from OLS regressions between the Conference Board Coincident Indicator year-over-year rate of change (dependent variable) and leads and lags of U.S. equity realized volatility (independent variable). Newey-West Standard Errors are computed. T- statistics are in bold italic. The estimated coefficients are significant at 1% level, with the exception of: ***significant at 5% level; **significant at 10% level; *not significant. Data frequency is on a monthly basis. Regressors are twelve leads and lags (1 year) of 12-month rolling annualised realized volatility of S&P500 index monthly returns. The period between October 1987 and September 1988 is excluded from the raw data because the substancial spike in realized volatility, which was a function of the October 1987 equity market crash, was an equity market phenomenom without any major consequences for the US economy. The October 1987 crash effect in rolling realized volatilty was completely faded away in October 1988. Source: Bloomberg.

4.2.2 *Implied Volatility*

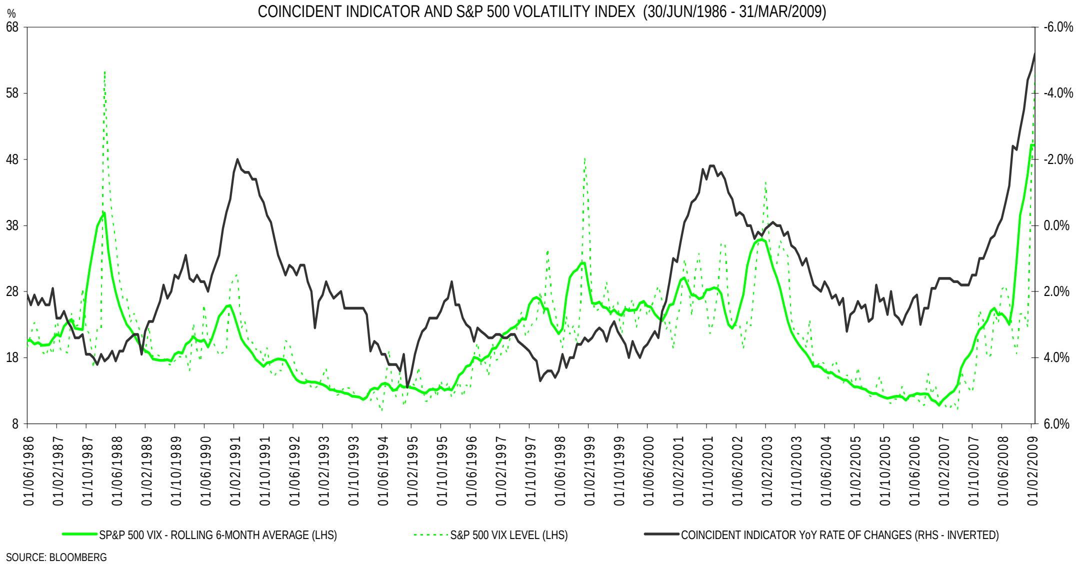


Figure 7: Coincident indicator and VIX

Analysis is also performed between implied volatility, measured by the VIX index, and COI YoY. The raw data available corresponds to the historical record of VIX, which dates back to January 1986. In the same vein, a sample partition is considered in order to avoid the equity market crash of October 1987, so the time horizon between October 1987 and September 1988 is not subject to statistical analysis, due to reasons of high volatility persistence already exposed in the previous section. Similar methodology of lead-lags is adopted, with 12 leads and lags applied to the volatility measure. Furthermore, the rolling six-month level of VIX is used instead of the original series levels because this shows a high noise pattern (Figure 7). This way, the series used is smoother and exhibits a similar pattern to COI YoY. Preliminary tests were done between different metrics of VIX and economic growth, and the rolling six-month average level showed the highest correlation. Results obtained from the month-end level, year-over-year rate of change, rolling three-month average level and rolling twelve-month average level, of the VIX, did not show any degree of correlation with economic growth. In Table 3, results for the 6-month rolling average of VIX are shown.

Given the information of OLS regressions, it is possible to conclude that the smoothed VIX seems to be a better explanatory variable than historical volatility of economic growth, in the comparable sample between October 1988 and March 2009. In this period, 26% of the variability of COI YoY is explained by the variability of the rolling six-month average of VIX level, one-month lagged, with the estimated coefficients being always negative. In other words, the 6-month average of annualized volatility levels implied in the S&P 500 options pricing, at the end of each month and for the next 30 calendar days, is a better explanatory variable of the year-over-year rate of economic growth, than the last twelve months annualised volatility of returns of the S&P 500. Considering the raw data (January 1986 - March 2009), the correlation is not so high, given the R^2 of 0.16 with the VIX one month lagged. In the sub-sample regression all the coefficients between lead 5 and lag 11 are statistically significant at 1.00% level. Leads 6, 7 and lag 12 are statistically significant at 5% level, and leads 10, 11 and 12 are not statistically significant. However, in the full-sample regression estimated coefficients of lags 1 to 8, contemporaneous level and leads 1 and 2 of the explanatory variable are the most significant at 5% significance level. Additionally, the results profile is similar in terms of the volatility lags being more significant in explaining economic growth than the equivalent leads. Also there seems to be a contemporaneous, with a slight monthly lead, significant relationship of implied volatility and US economic growth.

TABLE 3

EQUITY VOLATILITY INDEX (VIX)

REGRESSION WITH S&P500 VOLATILITY INDEX - VIX		
	TIME PERIODS	
VIX LEAD (MONTHS)	31/JAN/1986 - 31/MAR/2009	31/OCT/1988 - 31/MAR/2009
+ 12 LEAD	0.01	0.01
	-0.59 *	***-0.69*** *
+ 11 LEAD	0.01	0.02
	-0.76 *	***-0.93*** *
+ 10 LEAD	0.01	0.03
	-0.93 *	***-1.19*** *
+ 9 LEAD	0.02	0.04
	-1.08 *	***-1.47*** **
+ 8 LEAD	0.03	0.05
	-1.25 *	***-1.77*** **
+ 7 LEAD	0.04	0.07
	-1.42 *	***-2.08*** ***
+ 6 LEAD	0.05	0.09
	-1.59 *	***-2.41*** ***
+ 5 LEAD	0.06	0.12
	-1.74 **	***-2.72***
+ 4 LEAD	0.08	0.15
	-1.88 **	***-2.99***
+ 3 LEAD	0.10	0.18
	-1.89 **	***-3.23***
+ 2 LEAD	0.12	0.21
	-2.01 ***	***-3.43***
+ 1 LEAD	0.14	0.24
	-2.12 ***	***-3.59***
CONTEMPORANEOUS	0.16	0.26
	-2.21 ***	***-3.73***
- 1 LAG	0.16	0.27
	-2.22 ***	***-3.76***
- 2 LAG	0.15	0.26
	-2.19 ***	***-3.69***
- 3 LAG	0.13	0.24
	-2.12 ***	***-3.55***
- 4 LAG	0.11	0.22
	-2.17 ***	***-3.42***
- 5 LAG	0.09	0.20
	-2.13 ***	***-3.33***
- 6 LAG	0.08	0.17
	-2.10 ***	***-3.27***
- 7 LAG	0.06	0.15
	-2.03 ***	***-3.18***
- 8 LAG	0.05	0.13
	-1.97 ***	***-3.08***
- 9 LAG	0.05	0.12
	-1.94 **	***-2.97***
- 10 LAG	0.05	0.11
	-1.89 **	***-2.86***
- 11 LAG	0.04	0.10
	-1.85 **	***-2.71***
- 12 LAG	0.04	0.09
	-1.78 **	***-2.55*** ***

Note: This table reports R-squared and t-statistics from OLS regressions between the Conference Board Coincident Indicator year-over-year rate of change (dependent variable) and leads and lags of U.S. equity implied volatility (independent variable). Newey-West Standard Errors are computed. T- statistics are in bold italic. Estimated coefficients are significant at 1% level. If not: ***significant at 5% level; **significant at 10% level;*not significant. Data frequency is on a monthly basis. Regressors are twelve leads and lags (1 year) of 6-month average level of CBOE Volatility Index (VIX) based on options on the S&P500. Two periods are considered: (a) one between January 1986 and March 2009, which consists of the historical record from the VIX; (b) another between October 1988 and March 2009, in order to exclude the substancial spike in implied volatility that was function of the October 1987 equity market crash, and being an equity market phenomenom it did not provoke any major consequences for the US economy. The October 1987 crash effect in implied volatilty was completely faded away in October 1988. Source: Bloomberg.

4.3 MONEY MARKETS VOLATILITY

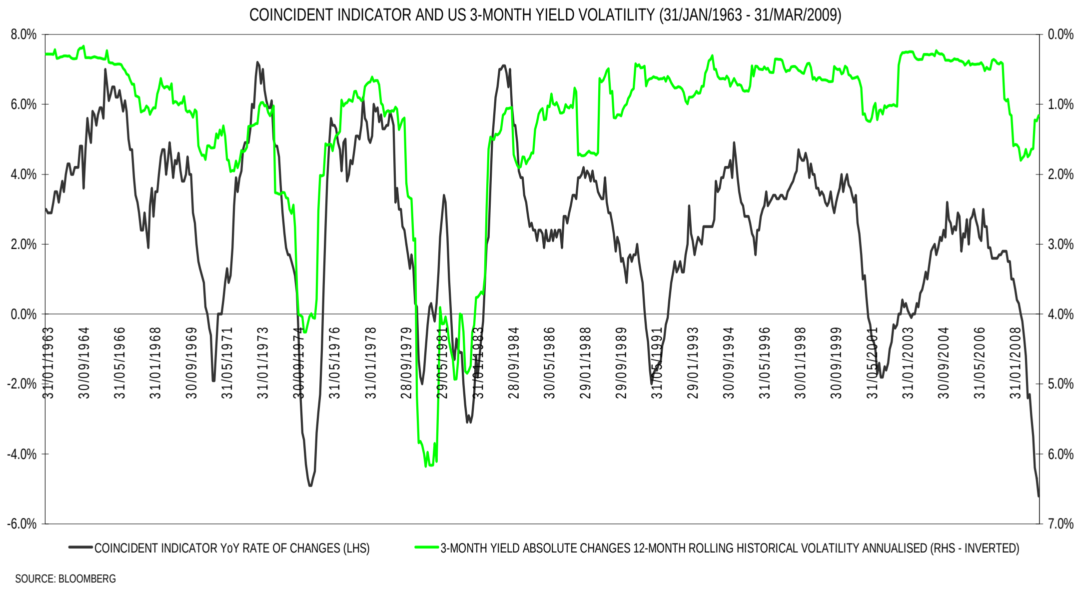


Figure 8: Coincident indicator and 3-month yield historical volatility

In the case of money markets, besides estimating the regression models using the raw data, as in equities, I also considered two distinct periods, the first one starting in January 31, 1963 and ending in December 31, 1984 and the second one from January 31, 1985 to March 31, 2009. Results are shown in Table 4.

According to Figure 8, it is clear that there was a visible negative correlation between the rate of economic growth (COI) and 3-month volatility in the first period, but in the second time-frame there is no apparent correlation between the two variables. Monetary policy factors are an important issue to explain the regime change. Until the mid-1980s monetary policy decisions taken by the Federal Reserve were demand side oriented , and when the U.S. economy was affected by the oil supply shocks, generating high rates of inflation, the Central Bank cut rates and that propelled even more the inflation threat. As a consequence the volatility of inflation spiked up and also the volatility of interest rates. After the oil crisis of the 1970s and 1980s, not only the volatility and trend of inflation went down but also the communication policies of interest rate decisions turned out to be much more transparent for the markets, both generating a structurally lower volatility and risk premium of short-term yields.

In terms of the full-sample data, OLS estimated regressions outputs show that the variability of volatility of 3-month bills explains, by 22%, the variability of the year-over-year rate of changes of COI. The estimated coefficients are negative, meaning that when the interest rate volatility is higher the rate of change of the economy tends to slow-down. After 3 months lag periods applied to the explanatory variable, the R^2 is lower, meaning that the relationship is more contemporaneous than lagged. Conversely, when leads are considered for volatility, the correlation is lower when compared to the same distance lags. However, estimated coefficients are all statistically significant at 1% level until when 10 leads-lags are considered.

Considering the first sub-period (1963-1984) for estimating the model, the results obtained are much more significant than the ones for the raw data, with the coefficients being always negative. The R^2 values are substantially higher for all the analysis of contemporaneous, leads and lags of the short-interest rate volatility. At coincident and 1 lagged period of volatility, the R^2 obtained are the highest (0.56), and when other higher lags and the leads are considered the coefficient of determination turns lower. Furthermore, the estimated coefficients are all statistically significant at 1% level in all leads-lags considered. Hence, in this period, and given the lower transparency of monetary policy associated to the oil crisis that affected the U.S. economy, rising volatility of short-term rates and inflation premium happened when the economy entered into a downturn (as a consequence of the inflation shock).

Finally, the period that many authors call *The Great Moderation*, was characterized by reduced volatility of output growth in the mid-1980s relative to the three earlier decades (Kose et al., 1999), being a function of lower volatility in durable goods production, better inventory management (McConnell and Perez-Quiros, 2000), and by a better monetary policy (Bernanke, 2004a). For the second sub-sample data, the estimated models show absence of correlation between short rates volatility and the economic cycle, with the highest R^2 at 6%. Moreover, the estimated coefficients are not statistically significant, irrespectively of the leads-lags applied to the volatility. According to Figure 8, it is possible to see a structural lower range in the financial volatility, which is independent of the upward and downward trends in the rate of change of COI. However, the financial crisis that began in 2007 (generating a deep economic recession) propelled substantial policy action by the Federal Reserve that in turn raised volatility of pricing of short term financial instruments.

TABLE 4

3-MONTH YIELD HISTORICAL VOLATILITY

REGRESSION WITH US 3M TREASURY-BILL YIELD VOLATILITY			
	TIME PERIODS		
VOLATILITY LEAD (MONTHS)	31/JAN/1963 - 31/DEC/1984	31/JAN/1985 - 31/MAR/2009	31/JAN/1963 - 31/MAR/2009
+ 12 LEAD	0.10	0.02	0.02
	-3.70	***1.15*** *	***-1.68*** **
+ 11 LEAD	0.13	0.01	0.03
	-4.36	***1.00*** *	***-2.16*** ***
+ 10 LEAD	0.17	0.01	0.04
	-5.06	***0.86*** *	***-2.68***
+ 9 LEAD	0.21	0.01	0.06
	-5.65	***0.69*** *	***-3.18***
+ 8 LEAD	0.26	0.00	0.08
	-6.14	***0.59*** *	***-3.62***
+ 7 LEAD	0.30	0.00	0.10
	-6.54	***0.39*** *	***-4.01***
+ 6 LEAD	0.35	0.00	0.12
	-6.92	***0.16*** *	***-4.40***
+ 5 LEAD	0.39	0.00	0.14
	-7.25	***-0.05*** *	***-4.75***
+ 4 LEAD	0.43	0.00	0.16
	-7.51	***-0.27*** *	***-5.08***
+ 3 LEAD	0.47	0.00	0.18
	-7.68	***-0.48*** *	***-5.35***
+ 2 LEAD	0.51	0.01	0.19
	-7.78	***-0.66*** *	***-5.57***
+ 1 LEAD	0.54	0.02	0.21
	-7.73	***-0.82*** *	***-5.67***
CONTEMPORANEOUS	0.56	0.02	0.22
	-7.51	***-0.95*** *	***-5.62***
- 1 LAG	0.56	0.03	0.22
	-7.16	***-1.09*** *	***-5.43***
- 2 LAG	0.55	0.04	0.22
	-6.73	***-1.22*** *	***-5.15***
- 3 LAG	0.52	0.05	0.21
	-6.29	***-1.33*** *	***-4.82***
- 4 LAG	0.48	0.06	0.19
	-5.87	***-1.35*** *	***-4.45***
- 5 LAG	0.43	0.06	0.17
	-5.51	***-1.35*** *	***-4.10***
- 6 LAG	0.38	0.06	0.15
	-5.21	***-1.36*** *	***-3.78***
- 7 LAG	0.34	0.05	0.12
	-4.93	***-1.32*** *	***-3.46***
- 8 LAG	0.29	0.05	0.10
	-4.67	***-1.30*** *	***-3.15***
- 9 LAG	0.25	0.04	0.09
	-4.39	***-1.28*** *	***-2.83***
- 10 LAG	0.21	0.04	0.07
	-4.06	***-1.28*** *	***-2.50***
- 11 LAG	0.17	0.03	0.05
	-3.71	***-1.22*** *	***-2.14*** ***
- 12 LAG	0.14	0.03	0.04
	-3.33	***-1.20*** *	***-1.82*** **

Note: This table reports R-squared and t-statistics from OLS regressions between the Conference Board Coincident Indicator year-over year rate of changes (dependent variable) and leads and lags of 3-month constant maturity Treasury-Bills Yields (independent variable), considering rolling of T-Bills benchmarks. Newey-West Standard Errors are computed. T-statistics are in bold italic. The estimated coefficients are significant at 1% level. If not: ***significant at 5% level; **significant at 10% level; *not significant. Data frequency is on a monthly basis. Regressors are twelve leads and lags (1 year) of 12-month rolling annualized realized volatility of absolute changes of T-Bills yields. Two sub-sample periods (Jan/1963-Dec/1984 and Jan/1985-Mar/2009) are considered because of the substancial change in the pattern of short term yields. Source: Bloomberg.

4.4 GOVERNMENT DEBT VOLATILITY

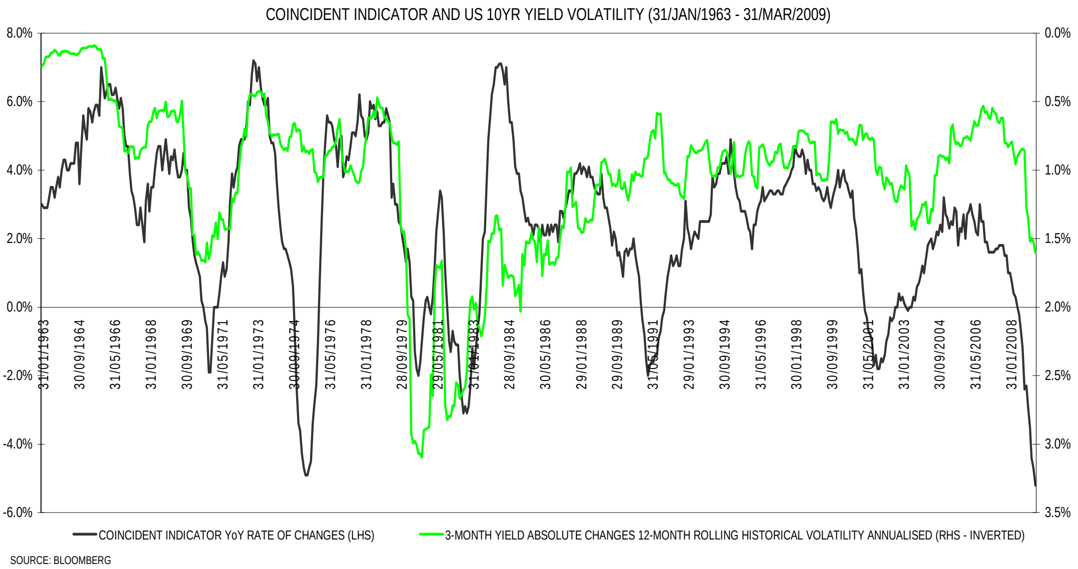


Figure 9: Coincident indicator and 10yr yield historical volatility

As in the case of short rates volatility, for the 10yr government bond yield analysis, I also considered the same two distinct periods apart from the entire sample (given the same type of lower range in Figure 9). Considering that a different risk premium is implied in the 10yr yield, when compared to the short term yields, in essence the main risks inherent to a long term fixed income instrument, in a plain-vanilla government bond, are the average real growth and inflation expectations for the maturity of the instrument (vs. short term debt securities):

$$\begin{aligned}&Nominal\_Yield_{Goverment(Z),T} = Nominal\_Short\_Term\_Yield_{(Z),0}\\&+Real\_Growth\_Premium_{(Z),T} + Inflation\_Premium_{(Z),T}\end{aligned} \quad (8)$$

Where

Government (Z) is the sovereign credit rating

T is the time to maturity of the bond

0 is the overnight time to maturity

In other words, a 10yr yield is nothing more than the average path of short term yields expected for the next 10 years. Although this relationship is applied more rigorously to spot and forward interest rates definitions, given that the concept of yield-to-maturity derives mathematically from spot rates, the same rational can be considered in the yield-to-maturity space.

The profile of estimated models is similar to the results obtained for the 3-month bills, with the results being more significant in the period of January, 1963-December, 1984 (R^2 = 0.33 at the contemporaneous level), although less strong in all respects (Table 5). For the entire sample, the R^2 obtained in the contemporaneous analysis is 0.18, and the same result is obtained in the first and second leads applied to the financial volatility variables. For higher gaps of leads and lags the significance of OLS regressions is reduced. Finally, in the period of the *Great Moderation*, the results obtained do not indicate any linear relationship between yield volatility and COI's rate of change. All the estimated coefficients are not statistically significant, with the exception of when the 8-12 lags are considered for volatility. In this case the estimated coefficients are significant at 10% level, although the correspondent R^2 values are too small.

Market professionals find two main types of reasons for the lower link between long term yield volatility and economic growth. Firstly, there is a broad consensus that the volatility transmission from the short to long end of the yield curve is partial, although with positive spill-over effects. Secondly, other factors have played a substantial role in the level and volatility of long term yields, like the increase in holdings of treasuries by foreign institutional investors due to currency pegging and surpluses of current account balances, that are not directly correlated with the U.S. economic and monetary policy cycles.

TABLE 5

10YR YIELD HISTORICAL VOLATILITY

REGRESSION WITH US 10YR US GENERIC GOVERNMENT BOND YIELD VOLATILITY			
	TIME PERIODS		
VOLATILITY LEAD (MONTHS)	31/JAN/1963 - 31/DEC/1984	31/JAN/1985 - 31/MAR/2009	31/JAN/1963 - 31/MAR/2009
+ 12 LEAD	0.13	0.05	0.06
	-3.66	-2.07 *	-2.78 ***
+ 11 LEAD	0.15	0.05	0.07
	-4.00	-1.98 *	-3.05
+ 10 LEAD	0.17	0.04	0.09
	-4.34	-1.83 *	-3.31
+ 9 LEAD	0.19	0.03	0.10
	-4.59	-1.60 *	-3.51
+ 8 LEAD	0.21	0.03	0.11
	-4.84	-1.37 *	-3.72
+ 7 LEAD	0.24	0.02	0.12
	-5.10	-1.19 *	-3.94
+ 6 LEAD	0.26	0.02	0.14
	-5.43	-1.03 *	-4.21
+ 5 LEAD	0.28	0.01	0.15
	-5.87	-0.87 *	-4.53
+ 4 LEAD	0.29	0.01	0.16
	-6.42	-0.76 *	-4.92
+ 3 LEAD	0.31	0.01	0.17
	-7.06	-0.64 *	-5.34
+ 2 LEAD	0.32	0.00	0.18
	-7.75	-0.49 *	-5.75
+ 1 LEAD	0.33	0.00	0.18
	-8.21	-0.32 *	-6.02
CONTEMPORANEOUS	0.33	0.00	0.18
	-8.20	-0.18 *	-6.01
- 1 LAG	0.33	0.00	0.17
	-7.83	0.08 *	-5.71
- 2 LAG	0.31	0.00	0.15
	-7.19	0.39 *	-5.24
- 3 LAG	0.29	0.00	0.14
	-6.46	0.82 *	-4.68
- 4 LAG	0.26	0.01	0.12
	-5.73	1.24 *	-4.12
- 5 LAG	0.23	0.02	0.10
	-5.06	1.53 *	-3.59
- 6 LAG	0.21	0.02	0.08
	-4.50	1.71 **	-3.16
- 7 LAG	0.18	0.02	0.07
	-4.01	1.81 **	-2.80
- 8 LAG	0.15	0.03	0.06
	-3.59	2.00 ***	-2.45 ***
- 9 LAG	0.13	0.03	0.04
	-3.21	2.16 ***	-2.13 ***
- 10 LAG	0.10	0.04	0.03
	-2.87	2.27 ***	-1.82 **
- 11 LAG	0.08	0.05	0.02
	-2.51 ***	2.37 ***	-1.50 *
- 12 LAG	0.06	0.05	0.01
	-2.15 ***	2.42 ***	-1.18 *

Note: This table reports R-squared and t-statistics from OLS regressions between the Conference Board Coincident Indicator year-over-year changes (dependent variable) and leads and lags of 10yr constant maturity Treasury-Notes Yields (independent variable), considering rolling of T-Notes benchmarks. Newey-West Standard Errors are computed. T-statistics are in bold italic. The estimated coefficients are significant at 1% level. If not: ***significant at 5% level; **significant at 10% level; *not significant. Data frequency is on a monthly basis. Regressors are twelve leads and lags (1 year) of 12-month rolling annualised realized volatility of absolute changes of T-Notes yields. Two sub-sample (Jan/1963-Dec/1984 and Jan/1985-Mar/2009) are considered because of the substancial change in the pattern of long term yields. Source: Bloomberg.

4.5 YIELD CURVE VOLATILITY

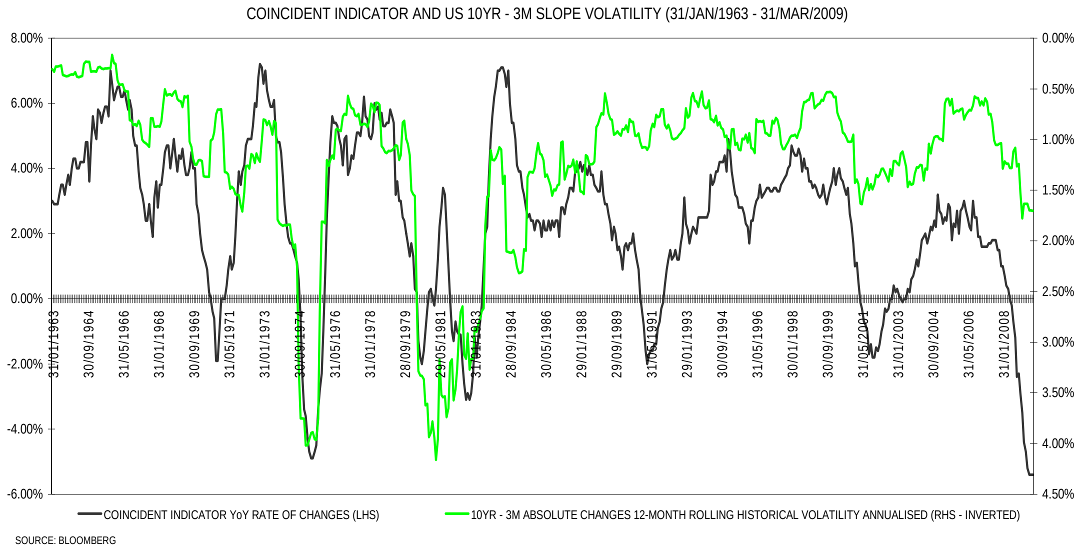


Figure 10: Coincident indicator and 10yr - 3m yield curve historical volatility

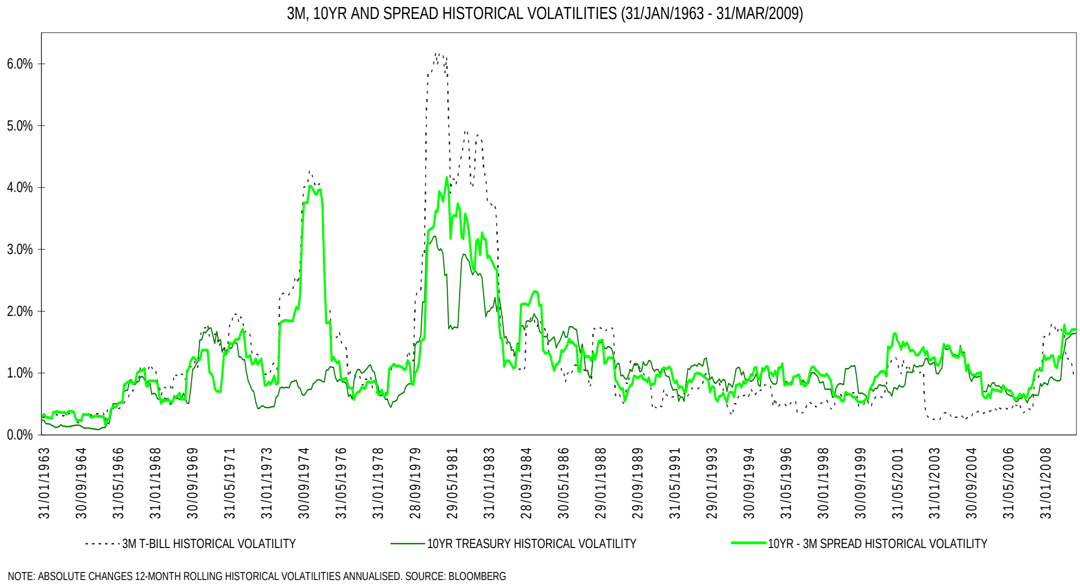


Figure 11: Yields and 10yr - 3m curve historical volatilities

Results from the estimated models using the volatility of the yield curve, as the explanatory variable for economic growth, seem statistically more significant than the ones obtained considering the individual maturity buckets. Figure 10 shows the historical relationship between the two variables and statistical outputs are included in Table 6. Regressions based on the full-sample (January, 1963 - March, 2009) show that the variability of curve changes volatility explain 29% of the variability of COI YoY, at the contemporaneous level. The results are marginally better when 2 lags in volatility are applied, with the R^2 value of 30% and t-statistics of the estimated coefficients (negative) at the highest absolute level for all lags-leads considered. Consequently, higher yield curve volatility leads the slowdown in the rate of change of the U.S. economy.

Considering the first sub-period (January, 1963 - December, 1984), although the R^2 values obtained are not higher than the ones from the estimated models using the 3-month rate, the outputs are still significant and the absolute value of t-statistics is higher. Once more, curve changes volatility leads, inversely, the rate of change of COI, with the coefficient of determination being the highest at the contemporaneous level (0.42). Moreover, in all the 12 leads-lags applied the estimated coefficients are statistical significant at 1% level.

Figure 11 shows the behaviour of the 3-month, 10yr and curve changes volatilities, and it is possible to see that in the first sub-sample period the short-end volatility was consistently higher than the 10yr equivalent metric, being the main driver of the curve changes volatility. When the estimated models are based on the second sub-period (January, 1985 - March, 2009), output results are more robust than the single maturity volatility analysis. At the coincident level, the variability of COI YoY is explained by 11%, with a negative estimated beta, by the curve volatility. However, given the leads-lags estimated models, it is possible to see that the best results (R^2 = 0.21, estimated coefficient statistically significant at 1.00% level and highest absolute value t-statistic) are obtained when 5 lags are applied to volatility, meaning that curve volatility is leading economic growth, with the estimated coefficients still negative. Some observations are worse to be considered. Firstly, in this period, and according to Figure 11, the volatility regime changed with the 10yr bucket being higher than the 3-month one and the principal driver of the yield curve volatility. Although, it is possible to conclude that the gradualism and more transparency approach, from the Federal Reserve, was the main cause for the reduced volatility in the short-end of the curve, it did not affect that directly the long-term yield variability. Besides other technical factors that have had impact in this bucket, one possible explanation for the switch in the regime of higher volatility in the 10yr, was the higher inflation risk premium incorporated in the long term bond yields as consequence of the inflation shocks of the 1970s and 1980s, that originated significant capital losses for the government bond market investors. Secondly, research done by Koo (2009), shows that (for the last decades) government bonds have been the less forward looking asset class in terms of economic cycle turn anticipation, being more reactive to economic news flow and policy decisions than proactive. Hence, the better results obtained with 6-month lead applied to the curve volatility variable in the more recent sub-period, meaning that curve volatility changes have been laggard of the economy rate of growth, when 10yr volatility has been above the 3-month one.

TABLE 6

10YR - 3M YIELD SPREAD HISTORICAL VOLATILITY

REGRESSION WITH US 10YR - 3M CURVE LEVEL VOLATILITY			
	TIME PERIODS		
VOLATILITY LEAD (MONTHS)	31/JAN/1963 - 31/DEC/1984	31/JAN/1985 - 31/MAR/2009	31/JAN/1963 - 31/MAR/2009
+ 12 LEAD	0.05	0.00	0.02
	-2.66	***0.39*** *	***-1.89*** **
+ 11 LEAD	0.08	0.00	0.03
	-3.25	***0.05*** *	***-2.46*** ***
+ 10 LEAD	0.10	0.00	0.05
	-3.82	***-0.30*** *	***-3.02***
+ 9 LEAD	0.13	0.01	0.07
	-4.33	***-0.65*** *	***-3.53***
+ 8 LEAD	0.13	0.01	0.09
	-4.33	***-0.96*** *	***-3.98***
+ 7 LEAD	0.20	0.02	0.12
	-5.09	***-1.25*** *	***-4.39***
+ 6 LEAD	0.24	0.03	0.14
	-5.36	***-1.52*** *	***-4.74***
+ 5 LEAD	0.27	0.05	0.17
	-5.60	***-1.78*** **	***-5.06***
+ 4 LEAD	0.31	0.06	0.20
	-5.87	***-2.02*** ***	***-5.39***
+ 3 LEAD	0.35	0.07	0.23
	-6.14	***-2.28*** ***	***-5.71***
+ 2 LEAD	0.38	0.08	0.26
	-6.32	***-2.55*** ***	***-5.95***
+ 1 LEAD	0.41	0.10	0.28
	-6.35	***-2.86***	***-6.08***
CONTEMPORANEOUS	0.42	0.11	0.29
	-6.27	***-3.16***	***-6.10***
- 1 LAG	0.41	0.13	0.30
	-6.13	***-3.53***	***-6.06***
- 2 LAG	0.39	0.16	0.30
	-5.96	***-3.84***	***-5.96***
- 3 LAG	0.37	0.18	0.29
	-5.84	***-4.09***	***-5.86***
- 4 LAG	0.34	0.20	0.27
	-5.76	***-4.20***	***-5.79***
- 5 LAG	0.32	0.21	0.25
	-5.67	***-4.14***	***-5.69***
- 6 LAG	0.28	0.21	0.23
	-5.49	***-3.98***	***-5.51***
- 7 LAG	0.25	0.20	0.20
	-5.23	***-3.77***	***-5.27***
- 8 LAG	0.22	0.18	0.18
	-4.89	***-3.53***	***-4.94***
- 9 LAG	0.19	0.15	0.15
	-4.48	***-3.26***	***-4.54***
- 10 LAG	0.17	0.13	0.13
	-4.11	***-2.96***	***-4.14***
- 11 LAG	0.15	0.10	0.11
	-3.80	***-2.65***	***-3.75***
- 12 LAG	0.14	0.08	0.09
	-3.58	***-2.33*** ***	***-3.42***

Note: This table reports R-squared and t-statistics from OLS regressions between the Conference Board Coincident Indicator year-over-year rate of changes (dependent variable) and leads and lags of the curve spread between 10yr constant maturity Treasury-Notes yields and 3m constant maturity Treasury-Bills yields (independent variable), considering rolling of benchmarks. Newey-West Standard Errors are computed. T- statistics are in bold italic. The estimated coefficients are significant at 1% level. If not: ***significant at 5% level; **significant at 10% level; *not significant. Data frequency is on a monthly basis. Regressors are twelve leads and lags (1 year) of 12-month rolling annualised realized volatility of the spread level. Two sub-samples (Jan/1963-Dec/1984 and Jan/1985-Mar/2009) are considered because of the substancial change in the pattern of treasury yields. Source: Bloomberg.

4.6 CREDIT MARKETS VOLATILITY

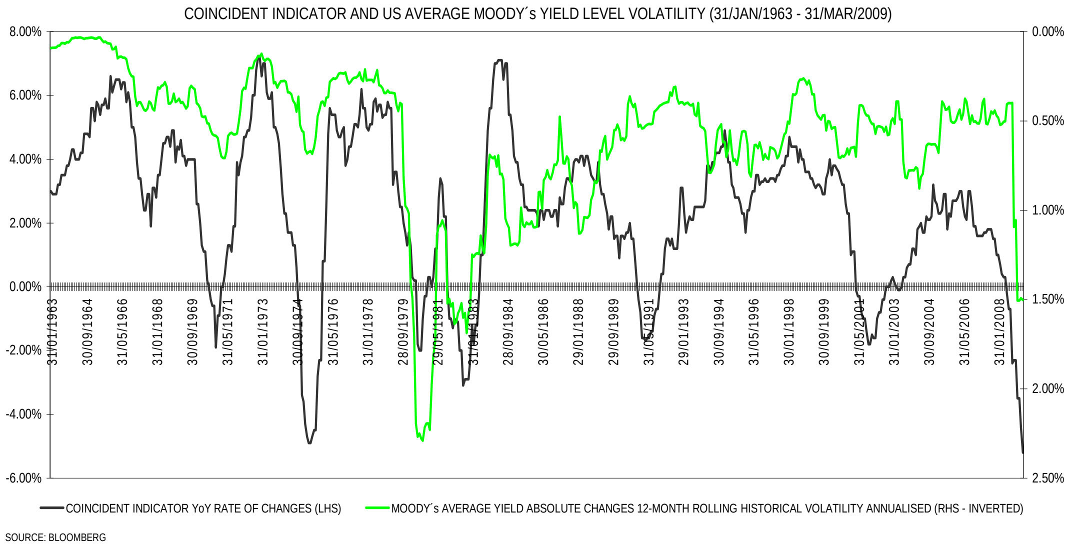


Figure 12: Coincident indicator and Moody's yield historical volatility

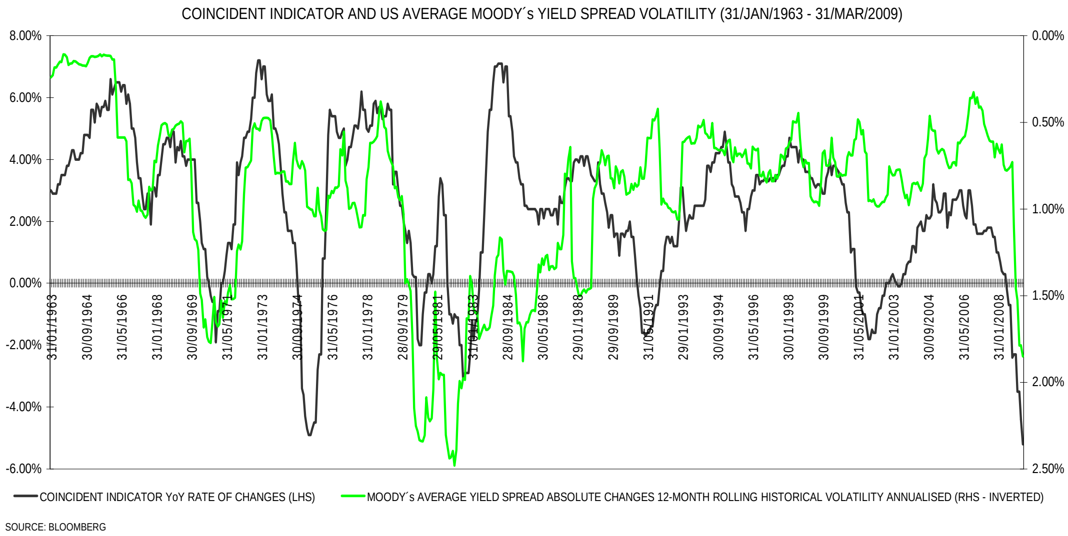


Figure 13: Coincident indicator and Moody's yield spread historical volatility

In order to find the interaction between credit risk volatility and economic growth, two different approaches can be considered on the explanatory variable: the yield and the spread level.

The corporate bond yield, for a certain maturity *(T)* with rating *(Z)*, can be calculated as

$$Yield_{Corporate,Z,T} = Yield_{Risk-Free,T} + Credit\_Risk\_Spread_{Z,T} \tag{9}$$

According to equation (9), volatility changes in the corporate bond yield can be function of the variability of its risk-free component, of the credit spread or from the two components simultaneously. This way, I have estimated the model based on two different regressors (the composite corporate yield and the spread). Results for the yield and the spread are shown in Tables 7 and 8, respectively.

From a theoretical point of view, the spread component is the true source of credit risk of the corporate or financial issuer, which in turn should produce the best results of the estimated model in capturing the dynamics between credit risk and economic growth. However, for results comparison, I also performed regressions using the composite yield, although having in mind that the risk-free component (already tested) also contributes to the outputs obtained.

Given the structural change that occurred in the relationship of yield level and spreads with the rate of change of economic growth, in the mid-1980s, besides the full-sample data, the same sample partition, as in the case of money markets and government bonds, were also considered for the analysis.

4.6.1 *Corporate Bond Yield Level*

Results obtained for the full-period (January, 1963 - March, 2009) show that the estimated coefficients are negative, for all leads-lags, and the relationship is stronger at the contemporaneous level, with the R^2 of 0.21 and statistically significant at 1.00% level. Additionally there is no substantial lead-lag effect of the financial variable in explaining COI YoY, as the higher are the gaps considered less significant are the estimated models in terms of lower coefficients of determination and significance level. Consequently, the relationship is very contemporaneous meaning that a rise or fall in the historical volatility of the corporate bond yield does not anticipate a fall or rise in the rate of economic growth. For the January, 1963 - December, 1984 period, results are more relevant, with higher R^2 and more statistically significant estimated coefficients for all leads-lags considered. Moreover, all the coefficients are negative and statistically significant at 1.00% level, with the exception of the 12 lag that is significant at 5.00% significance level.

In the second sub-sample (January, 1985 - March, 2009), the relationship is not statistically significant for most of lead and lags considered, meaning that there was no statistical evidence of linear interaction between credit volatility and growth. Although the estimated coefficients are positive, being contrary to the theoretical assumptions. However, strong conclusions based on the regression results should not be taken given the weakness of correlation between the two variables and the significance of the estimated coefficients.

4.6.2 *Corporate Bond Yield Spread*

The outputs from the estimated models (Table 8) exhibit a similar profile of the ones from the yield level volatility. Although the results are marginally less significant, they only reflect the interaction between the credit risk component of pricing of this asset class and economic growth. When the full-sample is considered in the estimated regressions, results show that the relationship between the two variables is statistically significant at the contemporaneous level, with a coefficient of determination of 0.15. The estimated coefficients are negative, in all lead-lags of the explanatory variable, meaning that when the credit spread volatility shows a positive innovation the rate of economic growth tends to slow down. Furthermore, the estimated coefficients are all statistically significant at 1.00% level, with the exception of the 12^{th} lead and 9^{th} up to 11^{th} lag of credit spread volatility that are significant at 10% level and the 12^{th} lags that is insignificant. In the period of January, 1963 to December, 1984, as for the yield level, results are statistically more significant, with all leads-lags of volatility estimated coefficients statistically significant at 1% level. When both variables are coincident in time, 32% of the variability of COI YoY is explained by the variability of the credit spread volatility. Finally, in the second sub-period, there is no statistical relationship between both variables (the exceptions are lags 11 and 12 that are statistically significant at 10% level). R^2 values are almost zero and the estimated coefficients from the regressions are almost not statistically significant.

TABLE 7

CORPORTATE YIELD LEVEL HISTORICAL VOLATILITY

REGRESSION WITH US AVERAGE MOODY´S YIELD LEVEL VOLATILITY

	TIME PERIODS		
VOLATILITY LEAD (MONTHS)	31/JAN/1963 - 31/DEC/1984	31/JAN/1985 - 31/MAR/2009	31/JAN/1963 - 31/MAR/2009
+ 12 LEAD	0.09	0.01	0.03
	-2.82	0.60 *	-1.84 **
+ 11 LEAD	0.11	0.01	0.04
	-3.16	0.64 *	-2.15 ***
+ 10 LEAD	0.13	0.01	0.05
	-3.52	0.64 *	-2.50 ***
+ 9 LEAD	0.16	0.64	0.07
	-3.86	0.01 *	-2.85
+ 8 LEAD	0.19	0.01	0.08
	-4.23	0.60 *	-3.22
+ 7 LEAD	0.21	0.01	0.10
	-4.66	0.59 *	-3.61
+ 6 LEAD	0.24	0.01	0.12
	-5.13	0.47 *	-4.06
+ 5 LEAD	0.27	0.00	0.14
	-5.64	0.36 *	-4.52
+ 4 LEAD	0.29	0.00	0.16
	-6.19	0.27 *	-5.00
+ 3 LEAD	0.31	0.00	0.18
	-6.76	0.17 *	-5.50
+ 2 LEAD	0.34	0.00	0.19
	-7.30	0.15 *	-5.92
+ 1 LEAD	0.35	0.00	0.20
	-7.59	0.11 *	-6.13
CONTEMPORANEOUS	0.35	0.00	0.21
	-7.59	0.06 *	-6.12
- 1 LAG	0.35	0.00	0.20
	-7.36	0.26 *	-6.00
- 2 LAG	0.34	0.01	0.18
	-6.78	0.53 *	-5.63
- 3 LAG	0.31	0.02	0.16
	-6.08	1.02 *	-5.15
- 4 LAG	0.29	0.04	0.14
	-5.43	1.91 **	-4.62
- 5 LAG	0.26	0.05	0.12
	-4.86	2.37 ***	-4.13
- 6 LAG	0.22	0.07	0.10
	-4.37	2.56 ***	-3.62
- 7 LAG	0.19	0.06	0.09
	-3.99	2.52 ***	-3.31
- 8 LAG	0.17	0.06	0.08
	-3.68	2.46 ***	-3.05
- 9 LAG	0.14	0.05	0.06
	-3.35	2.32 ***	-2.78
- 10 LAG	0.11	0.04	0.05
	-3.03	2.17 ***	-2.52 ***
- 11 LAG	0.09	0.03	0.04
	-2.72	1.98 ***	-2.26 ***
- 12 LAG	0.07	0.03	0.04
	-2.42 ***	1.82 **	-2.02 ***

Note: This table reports R-squared and t-statistics from OLS regressions between the Conference Board Coincident Indicator year-over-year rate of changes (dependent variable) and leads and lags of the Average Rating Moody's Yield Level (independent variable). Newey-West Standard Errors are computed. T- statistics are in bold italic. The estimated coefficients are significant at 1% level. If not: ***significant at 5% level; **significant at 10% level; *not significant. Data frequency is on a monthly basis. Regressors are twelve leads and lags (1 year) of 12-month rolling annualised realized volatility of absolute changes in the yield level. Two sub-samples (Jan/1963-Dec/1984 and Jan/1985-Mar/2009) are considered because of the substancial change in the pattern of yield level changes. Source: Bloomberg.

TABLE 8

CORPORATE YIELD SPREAD HISTORICAL VOLATILITY

REGRESSION WITH US AVERAGE MOODY´S YIELD SPREAD VOLATILITY			
	TIME PERIODS		
VOLATILITY LEAD (MONTHS)	31/JAN/1963 - 31/DEC/1984	31/JAN/1985 - 31/MAR/2009	31/JAN/1963 - 31/MAR/2009
+ 12 LEAD	0.15	0.02	0.04
	-4.54	***-1.31*** *	***-2.43*** ***
+ 11 LEAD	0.17	0.02	0.05
	-4.93	***-1.22*** *	***-2.76***
+ 10 LEAD	0.19	0.01	0.06
	-5.29	***-1.06*** *	***-3.06***
+ 9 LEAD	0.21	0.01	0.07
	-5.55	***-0.87*** *	***-3.34***
+ 8 LEAD	0.23	0.01	0.09
	-5.78	***-0.72*** *	***-3.63***
+ 7 LEAD	0.25	0.00	0.10
	-5.99	***-0.56*** *	***-3.89***
+ 6 LEAD	0.27	0.00	0.11
	-6.22	***-0.52*** *	***-4.17***
+ 5 LEAD	0.28	0.00	0.12
	-6.56	***-0.44*** *	***-4.45***
+ 4 LEAD	0.29	0.00	0.13
	-6.96	***-0.40*** *	***-4.72***
+ 3 LEAD	0.30	0.00	0.14
	-7.36	***-0.42*** *	***-4.98***
+ 2 LEAD	0.31	0.00	0.15
	-7.74	***-0.42*** *	***-5.16***
+ 1 LEAD	0.32	0.00	0.15
	-7.75	***-0.43*** *	***-5.27***
CONTEMPORANEOUS	0.32	0.01	0.15
	-7.94	***-0.43*** *	***-5.20***
- 1 LAG	0.32	0.00	0.14
	-7.75	***-0.27*** *	***-5.00***
- 2 LAG	0.31	0.00	0.13
	-7.43	***-0.06*** *	***-4.75***
- 3 LAG	0.30	0.00	0.12
	-6.97	***0.27*** *	***-4.39***
- 4 LAG	0.28	0.00	0.11
	-6.41	***0.65*** *	***-3.97***
- 5 LAG	0.26	0.01	0.09
	-5.86	***1.10*** *	***-3.54***
- 6 LAG	0.24	0.01	0.08
	-5.34	***1.35*** *	***-3.16***
- 7 LAG	0.21	0.01	0.07
	-4.85	***1.37*** *	***-2.87***
- 8 LAG	0.18	0.01	0.06
	-4.41	***1.44*** *	***-2.57*** ***
- 9 LAG	0.16	0.02	0.05
	-4.02	***1.53*** *	***-2.29*** ***
- 10 LAG	0.14	0.02	0.04
	-3.62	***1.59*** *	***-2.02*** ***
- 11 LAG	0.11	0.02	0.03
	-3.25	***1.66*** **	***-1.74*** **
- 12 LAG	0.09	0.02	0.02
	-2.88	***1.66*** **	***-1.48*** *

Note: This table reports R-squared and t-statistics from OLS regressions between the Conference Board Coincident Indicator year-over-year rate of changes (dependent variable) and leads and lags of the spread between the Average Rating Moody's Yield Index and 10yr T-Notes Constant Maturity Yield (independent variable). Newey-West Standard Errors are computed. T- statistics are in bold italic. The estimated coefficients are significant at 1% level. If not: ***significant at 5% level; **significant at 10% level; *not significant. Regressors are twelve leads and lags (1 year) of 12-month rolling annualised realized volatility of absolute changes in the yield spread. Two sub-sample periods (Jan/1963-Dec/1984 and Jan/1985-Mar/2009) are considered because of the substancial change in the pattern of yield spreads. Source: Bloomberg.

4.6.3 *Interpretation of Corporate Yield Level and Spreads Results*

The statistical outputs, from the credit variables, raise some important aspects. Firstly, although the two variables are inversely correlated, there is no leading pattern of credit volatility to the rate of growth of the economy. According to financial theory, the current credit spread implies what market agents expect in terms of future corporate defaults. In other words, spreads are leading of defaults. However, the default cycle is laggard of the economic cycle, meaning that the peak or through of default rates, in the US, occurs after the peak or through of GDP (Erlandsson and Rennison (2008)). Consequently, even if spreads lead the default cycle they may not lead the economic cycle, being instead contemporaneous. Furthermore, considering that uptrends in credit volatility are associated to widening of spreads, then volatility is not also leading of economic growth. Secondly, the inexistence of correlation between credit volatility and growth since the mid-1980s, and the structural low pattern of volatility in this asset class (Figures 12 and 13) might be explained by financial innovation and the development of new derivative products. In fact, until the beginning of the 1990s trading in derivatives was essentially limited to over-the-counter and exchange-traded products such as futures, forwards, swaps and options that helped to manage risk changes in interest rates, exchange rates and equity prices. However since the mid-1990s there has been the development of credit derivatives like credit default-swaps and collateralised debt obligations which allowed investors to transfer credit risk, enhance credit market liquidity and hence to structurally reduce credit market volatility. According to Avramov et al (2006), by allowing scope for the transfer and dispersion of risks and the consequent rise in the fraction of credit risk assets controlled by informed agents holding diversified portfolios, the development of the credit derivatives class should create a more resilient market and thereby reduce volatility. However, and considering the financial crisis that started in 2007 which was motivated (between other factors) by a huge spike of credit spreads levels and volatility, previous studies (Laganà et al, 2006; Tucker, 2005) already had argued that at certain times these new instruments might increase asset price volatility.

4.7 RESULTS FROM CROSS CORRELATIONS

In order to investigate the existence of long lead-lag dynamics, beyond the 12-month tests already done (one year), cross correlations were computed with a lag specification of 60 observations (equivalent to 5 years), between COI YoY and the different asset classes (Appendix 3 - Panels A, B, C, D, E, F). The results obtained point to different conclusions, showing that in certain cases there are significant correlations with high leads-lags applied to the volatility.

In the case of equities volatility (Panels A and B), for both historical volatility and VIX, the outputs show that besides the strong contemporaneous negative correlations, there is a significant direct correlation when leads of volatility, between 2.5 years and 3 years (leads 30 to 39), are applied. At the 34th lead the correlation (measured by the R-squared) for S&P 500 historical volatility is 34% and for VIX is higher at 41%. It means that there is statistical evidence of equity volatility being laggard of economic growth, on a multi-year horizon analysis. A positive (negative) variation in the trend rate of economic growth leads to a positive (negative) variation in the volatility level 2.5 to 3 years latter. There is also evidence of a cyclical pattern of COI YoY, with the highest duration of upward and downward trends being 47 and 38 months, respectively (Appendix 9). This way, considering the statistical results of the negative contemporaneous relationship between equity volatility and economic growth, if in time t volatility goes up in tandem with a downturn in growth, it also goes up as a function of a positive shock in the upward trend rate of growth in time $t - i$ (with i = 2.5 to 3 years). In other words, the following rationale could be applied, according to Fisher (1933): if in time t the economy is growing then, *ceteris paribus*, the average market value of equity of the firms, in the economy, is also getting higher and the probability of their default is lower; consequently, risky assets trade on a more expensive basis, with lower risk premiums, and ultimately all the resources are expensive in way that can generate an inflation bubble (financial and real) in the economy; then, there is the deflation effect based on the evidence of the expensiveness of resources, given their intrinsic capabilities, with the agents of the economy selling overvalued resources and monetary and fiscal authorities implementing restrictive mechanisms; inevitably, uncertainty arises, distressed selling emerges, equity prices volatility rise and the rate of economic growth goes down.

In the case of short-term rates volatility (Panel C), cross-correlations show similar evidence as in equities, although not so significant. In fact, when 38 leads are applied to 3-month volatility the correlation obtained is 21%. So, besides the almost contemporaneous relationship between the two variables, on a multi-year horizon, economic growth leads volatility of short-term interest rates, in a direct relationship. As exposed above, if the economy growth reaches an unsustainable state, generating inflationary pressures, the Federal Reserve has to hike the Federal Funds Rate, thus, provoking instability in the risk premiums of money market rates and consequently rising volatility.

However, when long end rates and curve volatilities are considered (Panels D and E), the 60 lead-lags cross-correlation analysis shows that there is no multi-year significant dynamic with the economy rate of growth. A possible reason is that the monetary decision shocks in the short-term interest rates volatilities are smoothed and only partially transmitted to longer maturities in the term structure. In the same vein, if an inversion in the economic cycle can be contemporaneous of monetary policy decisions, and consequently of rising volatility of short rates, it does not mean that an inversion in the long term yields trend (and volatility) is also happening.

Finally, in the case of credit spreads (Panel F), results obtained for the 60 lead-lag analysis are similar to the 10yr rates and curve spread, meaning that there is no significant relationship between spreads volatility and economic growth, besides the contemporaneous analysis.

4.8 CAPITAL MARKETS PORTFOLIO PROXY VOLATILITY

In the case of CMP, besides the full-sample analysis, I also considered a sample partition each corresponding to one of the last five decades. The purpose was to find different dynamics between capital markets volatility and economic growth across those time periods. This way, models were estimated for the following periods: January, 1963-December, 1969; January, 1970-December, 1979; January, 1980-December, 1989; January, 1990-December, 1999 and January, 2000-March, 2009. In addition to this, given that changing regimes of correlation happened at different times with different asset classes, as discussed in the previous sections, I should not find an historical pattern based on a single asset class. Table 9 (Panels A and B) includes the results for all the analysis performed with CMP volatility as the explanatory variable of economic growth.

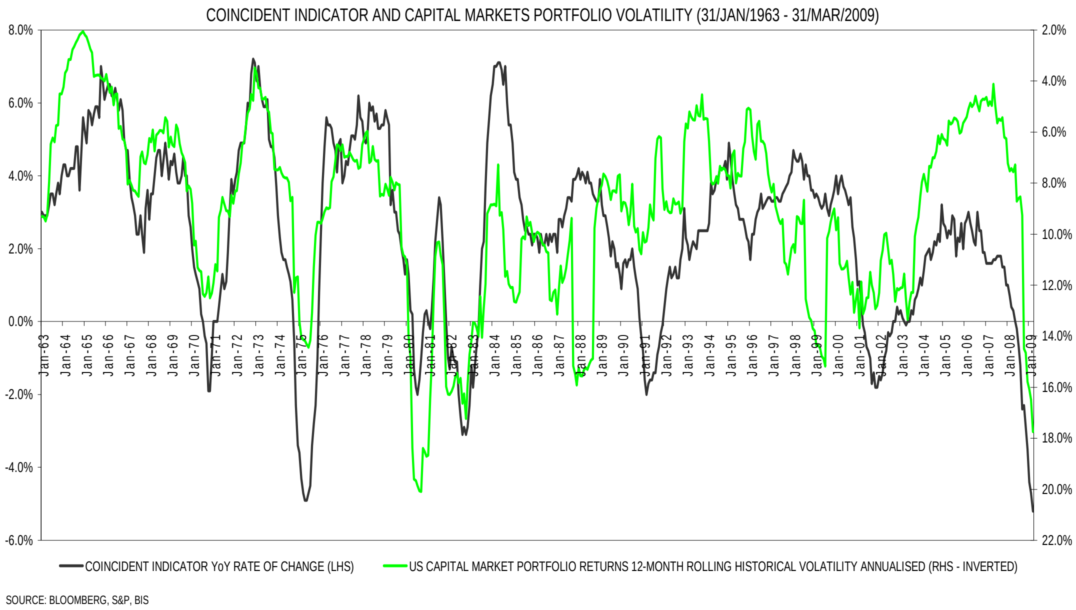


Figure 14: Coincident indicator and CMP proxy historical volatility

Outputs from regressions performed based on the full sample data show that there is a significant contemporaneous relationship between CMP volatility and COI YoY (Table 9 - Panel B). The R^2, of 0.31, at the coincident level is the highest of the lead-lags applied to volatility. The estimated coefficients are statistically significant at 1% level, with the exception of the 11th and 12th lags that are significant at 5% level. Moreover, the results for CMP are more significant than for any individual asset class considered, with the coefficient of determination and t-statistics (in absolute value) being the highest. Finally, Appendix 4 - Panel A consists of full-sample cross correlations between CMP and COI YoY, for 5 years (60 lags-leads), and it shows that the highest levels of correlation occur contemporaneously. However, regression outputs for the sub-sample periods show different regimes on the interaction between financial volatility and economic growth.

Beginning with the period from January, 1963 to December, 1969, the outputs from the estimated models exhibit a leading relationship of capital markets volatility in the economic growth pattern (Table 9 - Panel A). All the estimated coefficients of the 12 lags applied to volatility are negative and statistically significant at 1% level. The significance of the estimated models is stronger as lags are considered (until lag 7). With 7-month lags applied to volatility the R^2 value is 0.57 and the t-statistics obtained are the highest, in absolute value, of all 12 lead and lags considered in the analysis. This way, in this period, capital markets volatility is negatively correlated with the rate of economic growth, meaning that when there is an increase in financial variability the year-over-year rate of economic growth tends to slow down. Furthermore, the impact of volatility is the highest, when there is a difference of four to six months between that positive variation (in advance) and the consequent negative shock on the economic growth. On the other and, when leads are applied to volatility observations, testing if volatility can be laggard of economic growth, the results are less significant, with much lower levels for the coefficient of determination. However, for higher leads than 6 month applied, the estimated coefficients are positive, with the 10th lead statistical significant at 10% and 11th and 12th leads being statistical significant at 5.00%. In order to check if more leads would generate a more significant and direct relationship, I also computed cross-correlation coefficients, up to 60 months. In Appendix 4 (Panel B) it is possible to see that the direct correlation is the highest at the 18th month lead

(48.2%), meaning that a positive variation in the current year-over-year rate of economic growth is positively correlated with a future positive variation on financial volatility 1.5 years latter. In Figure 14, for the time frame considered, although there were periods of uptrend and downtrend of COI YoY rate, it never reached the negative growth territory and, according to NBER, there was only one month of official recession in December, 1969, which was the beginning of the December, 1969 - November, 1970 recession period. Moreover, and according to information in Appendix 5, between 1963 and 1969 the average growth rate was the highest and the difference between the extreme rates was the lowest, when compared to the other time periods. In the same way, as in Appendix 6, not only the median historical financial volatility was in the 1st quartile of the full-sample analysis but also its difference between the extreme observations was the lowest when compared to other decades. It is possible to argue that, given the smoothness of the upward and downward trends of the business cycle in the period, there were no substantial unpredictable shocks to the U.S. economy and, by that, the behaviour of financial variables, namely volatility, was in fact a counter-cyclical leading indicator of the economic cycle, with the empirical evidence being in line with the financial theory. Nevertheless, this conclusion should not be taken for the entire decade of 1960, not only because the raw data of the estimated model only starts in 1963 but also because in the period of April, 1960 - February, 1961 there was an official recession defined by NBER.

In the second period (1970 decade), the results from the estimated models show a much stronger negative relationship between volatility and growth (Table 9 - Panel A), with the highest correlation being at the coincident level (R^2 = 0.80). When more distant leads and lags, from the contemporaneous level, are applied to volatility the correlation decreases. However, all the estimated coefficients are significant at 1.00% level, with the exception of the 12th lead and 9th lag (significant at 5.00%) and the 10th to 12th lags (not significant). In Figure 14, it is possible to see the strong contemporaneous relationship between the variables. The 1970 decade (Appendix 5) was characterized by an average economic growth rate of 2.8%, below the level of 1963-1969, by the highest degree of dispersion of the time periods analysed (measured by the difference between maximum and minimum monthly observations of year-over-year economic growth rate) and by the occurrence of two recessions in the U.S. economy. The higher amplitude of the economic cycles in the 1970s was due to several shocks that affected the economy, namely the sharp increase in world wide inflation that followed the oil supply shock and also the poor monetary and fiscal responses that ultimately augmented the economic downturn. Many observers (e.g. Clarida et al, 2000 and Romer and Romer, 2002) suggested that monetary policy in the 1970s had a tendency to be destabilising, because at that time policymakers were too confident that activist policies could offset output shocks by trading off growth for inflation. Also Bernanke (2004b) argued that the trade off was a recipe for high volatility in output, inflation and financial markets. This way, and in opposite to the 1963-1969 juncture, not only the real activity was negatively affect by those exogenous forces but also markets participants were suddenly faced with substantial capital losses in several asset classes. Consequently, these could have been the main reasons for the inverse relationship between volatility and growth being much stronger and coincident, than in the previous period.

With regard to the time period of 1980 decade, the interaction between CMP volatility and COI YoY was not so significant as in the previous periods. The estimated coefficients for all the 12 month lead-lags are negative, as in the 1970 decade, meaning that financial volatility was counter-cyclical of economic growth. The highest degree of correlation is obtained at the first lead and coincident level, with R^2 of 0.38 and 0.37, respectively. At the same time, the estimated coefficient with the highest absolute t-statistic value is obtained in the volatility 2nd lead regression. Furthermore, the estimated coefficients are statistically significant at 1.00% level, until 6th lag and 7th lead. This way the outputs, in Table 9 - Panel A, show a contemporaneous relationship between the two variables, although with a slightly laggard impact of volatility relative to growth. As it is possible to see in Appendix 5, this decade was characterized by an average monthly YoY growth rate and degree of dispersion, similar to the 1970s ones, and also by two economic recessions, although the results obtained show significant differences. This might be due to different patterns of growth and volatility between the first and second half of 1980s. In fact, the pattern of the 1980-1985 period was similar to the 1970s one, with the two NBER recessions occurring in the time horizons from January, 1980 to July, 1980 and from July, 1981 to November, 1982. Moreover, extreme growth rate levels (in Appendix 5) also occurred in the first five years of the decade. Also, in this sub-period, there was the second oil shock and the continuation of demand driven monetary and fiscal policies. In terms of CMP historical volatility, the highest levels of the full-sample were reached (Appendix 6). On the other hand, in the second half of the 1980s, there were no recessions occurring and the monthly observations of YoY economic growth rate never reached negative readings. The initiation of the *Great Moderation* period of economic activity and also the gradualism of monetary policies is thought, by many researchers, has having started in the second half of the 1980 decade. Simultaneously, the equity crash of 1987 not only provoked a huge spike in equity volatility measures but also partially affected other asset classes, like credit spreads and money market rates volatilities and, to a lesser extent, government and corporate yield variability (Figures 8, 9, 12 and 13). However, the U.S. economy growth rate was not negatively affected by that financial phenomenon. So, according to Figure 14, it is possible to argue that, between 1980 and 1985, the relationship had been similarly robust as in the 1970s, and much less significant in the second half of the decade (statistical analysis of these sub-periods is beyond the scope of this thesis).

When the period, corresponding to the 1990 decade, is considered the results obtained are substantially different not presenting any similarities with the other sub-samples (Table 9 - Panel B). The outputs show the absence of correlation between financial volatility and economic growth, with R^2 values for all the lead-lags considered being very low. The estimated coefficients are not statistically significant in the majority of the regressions performed, and are positive between the 3rd lead and the 12th lag indicating a positive relationship between volatility and economic growth. However, given the results obtained, no empirical conclusions should be taken in terms of the pro-cyclical/counter-cyclical dynamic between the two variables. Furthermore, in order to check if there are lag-lead effects beyond

12-month observations, I computed cross correlations, for 60 lags (5 years) and concluded that at the 28th lag of volatility the direct correlation is the highest, at c.0.35 (see Appendix 4 - Panel C). In addition to this, I also performed the OLS regression, applying 28 lags to volatility, and found that the R^2 is high, of 0.29, and the positive estimated coefficient is statistically significant at 1.00% level. In terms of economic profile, the average YoY growth rate was similar to the 1980s and 1970s ones, the difference between the highest and lowest rates was smaller and there was only one recession occurring (between July, 1990 and March, 1991). In other words, the business cycle was smoother than in the previous two decades. In terms of volatility profile, according to Appendix 6, although the median monthly observation of historical volatility of CMP was in the 3rd quartile of the full-sample data (although near of the 2nd quartile region) the difference between the extreme observations was the 2nd lowest of the analysed time periods. With a closer inspection at the asset class level (Appendix 7) it is possible to see that average individual volatilities lie in the 2nd quartile region and that the extremes differences are the lowest, with the exception of equities that is higher than the 1963-1969 period difference. This way, an economic juncture without extreme peak/through growth evolutions was coupled with a lower than average volatility dispersion regime. Indeed, Figure 14 shows that historical volatility was persistently lower in great part of the decade, without an inverse correlation with the cyclical downturn in COI YoY (which coincided with the decade recession) and only rising to higher levels in the second half of 1997, with the emerging markets and Long Term Capital Management (LTCM) crisis. Several factors that could be behind the absence of relationship between volatility and growth have already been discussed in previous sections. In this vein, the macroeconomic changes (like the moderation of economic volatility and more transparency in the conduct of monetary policy) and financial markets developments (the increasing markets liquidity, the growing importance of financial institutional investors like pension funds and hedge funds and credit risk derivatives development), that took place in the second half of the 1980s, consolidated their tendencies in the 1990 decade. However, the statistical evidence that CMP volatility directly leads COI YoY, in more than two years time horizon (28th lag), empirically proves the following line of though - if current capital markets volatility suffers a positive innovation shock then, according to Merton (1974), the firms assets volatility also go up. If assets volatility rise than increases the probability of firms getting insolvent due to a devaluation of assets to a level below their book-value of debt. As a consequence, the capital markets securities simultaneously will register a fall in their market prices and will trade at a higher discount yield and implied risk premiums. Finally, since financial theory (Fama, 1981; Fischer et al., 1984 and Barro, 1990) suggests that capital markets, namely equities, have predictive power for economic growth, because markets potential returns are a forward-looking variable incorporating expectations about future cash-flows and rates of growth, then securities current higher potential rates of return imply higher future economic growth.

In the period from January, 2000 to March, 2009, the profile of statistical results were similar to the ones obtained in the 1970 and 1980 decades, in terms of lead-lag dynamics, with the regression models generating the best results at the coincident level and the estimated coefficients being always negative (Table 9 - Panel B). Although less statistically significant than the outputs for the 1970 decade, the R^2 for the contemporaneous level of volatility is 0.41. The estimated coefficients are all statistically significant at 1% level with the exception of the 8th to 12th leads and the 10th to 12th lags. The average year-over-year economic growth rate was the lowest of the sub-samples, the dispersion, measured by the difference between the extreme growth rates, was the highest of all periods and there were two recessions. Consequently, and according to Figure 14, not only COI YoY went into negative territory, with the last observations of 2009 being the lowest levels of negative growth of the U.S. economy (since the beginning of the full-sample in 1963) but also, in the time period of 2004 - 2006, the highest levels of COI YoY, reached in the decade, were far below other previous peaks. In terms of volatility behaviour (Appendix 6), the average level was higher than in the 1990 decade, the median value was in the 3rd quartile of the full sample observations and the dispersion measure was the highest of all the time periods of the analysis. In Figure 14, it is also possible to see that, when the 2001 recession occurred, volatility was not counter-cyclical with the evidence being that it continued with the same pattern of the 1990 decade. This trend in volatility prevailed throughout the years with the lowest levels, since the 1963 - 1969 period, being achieved in the beginning of 2007. Indeed, from mid-2004 to 2006 volatility of short-term and long term interest rates, equities and corporate spreads was generally low relative to other periods (Figures 8, 9, 6 and 13). Besides the structural macroeconomic and financial markets changes, of the 1980s and 1990s, that continued to put downward pressure in capital markets volatility in great part of the 2000 decade, other factors also played a substantial role. According to BIS (2006), the changes taking place in the U.S. market for mortgage-backed securities, namely the reduction in the levels of dynamic hedging by MBS investors, due to a diminished incentive to refinance existing mortgages by households, and the increased popularity of adjustable rate mortgages induced lower hedging-related volatility with potential spill-over effects on short and long term government and corporate debt. Also, there was an increasing supply of options (offering protection from financial risks) from investors such as hedge funds, investment banks and pension funds. This brought lower price pressure on option prices, thus reducing implied volatility and feeding back to realised volatility. Consequently, there was not cyclicality of volatility and negative correlation with economic growth did not happen, until the end of 2006. However, there was a switch in this regime, with the first signs of financial turbulence in mid-2007. In all asset classes, historical volatility started to trend higher surpassing the levels verified since the end of the 1980 decade. The usefulness of historical parallels is very limited because there is no suitable precedent for the current conditions of the global financial and economic crisis. Although, conclusions about this juncture are yet premature and, thus, beyond the scope of this study, it is possible to argue that not only volatility and growth have been inversely correlated, but also higher volatility has interacted almost contemporaneously with economic downturn (see Appendix 8 for regression results). This way, in a regime of higher volatility and economic growth swings, the interaction between the two variables is higher and much coincident (as in the 1970 and 1980 recessions and expansions).

TABLE 9

PANEL A

CAPITAL MARKETS PORTFOLIO PROXY HISTORICAL VOLATILITY

REGRESSION WITH CAPITAL MARKETS PORTFOLIO VOLATILITY			
	TIME PERIODS		
VOLATILITY LEAD (MONTHS)	31/JAN/1963 - 31/DEC/1969	31/JAN/1970 - 31/DEC/1979	31/JAN/1980 - 31/DEC/1989
+ 12 LEAD	0.15	0.06	0.03
	2.58 ***	***-2.37*** ***	***-1.14*** *
+ 11 LEAD	0.10	0.10	0.04
	2.12 ***	***-3.08***	***-1.52*** *
+ 10 LEAD	0.08	0.16	0.06
	1.80 **	***-3.73***	***-1.92*** **
+ 9 LEAD	0.05	0.23	0.08
	1.40	***-4.30***	***-2.22*** ***
+ 8 LEAD	0.02	0.31	0.10
	0.83	***-4.93***	***-2.48*** ***
+ 7 LEAD	0.00	0.39	0.13
	0.27	***-5.62***	***-2.76***
+ 6 LEAD	0.03	0.47	0.15
	-0.37	***-6.43***	***-3.17***
+ 5 LEAD	0.02	0.56	0.19
	-0.95 *	***-7.38***	***-3.80***
+ 4 LEAD	0.06	0.64	0.24
	-1.54 *	***-8.61***	***-4.62***
+ 3 LEAD	0.12	0.70	0.30
	-2.25 ***	***-10.06***	***-5.40***
+ 2 LEAD	0.20	0.76	0.35
	-2.96	***-11.77***	***-5.69***
+ 1 LEAD	0.30	0.79	0.38
	-3.79	***-13.16***	***-5.53***
CONTEMPORANEOUS	0.39	0.80	0.37
	-4.56	***-13.76***	***-5.11***
- 1 LAG	0.45	0.78	0.35
	-5.08	***-13.07***	***-4.76***
- 2 LAG	0.51	0.74	0.31
	-5.45	***-11.48***	***-4.31***
- 3 LAG	0.57	0.67	0.26
	-5.68	***-9.51***	***-3.88***
- 4 LAG	0.59	0.58	0.22
	-6.00	***-7.69***	***-3.46***
- 5 LAG	0.59	0.48	0.18
	-6.22	***-6.07***	***-3.11***
- 6 LAG	0.59	0.37	0.15
	-6.41	***-4.75***	***-2.82***
- 7 LAG	0.57	0.26	0.12
	-6.51	***-3.66***	***-2.57*** ***
- 8 LAG	0.55	0.17	0.09
	-6.14	***-2.78***	***-2.28*** ***
- 9 LAG	0.52	0.09	0.08
	-5.71	***-2.05*** ***	***-2.04*** ***
- 10 LAG	0.46	0.04	0.06
	-5.18	***-1.37*** *	***-1.70*** **
- 11 LAG	0.40	0.01	0.04
	-4.50	***-0.74*** *	***-1.36*** *
- 12 LAG	0.36	0.00	0.03
	-4.16	***-0.07*** *	***-1.11*** *
Nº OF OBSERVATIONS	84	120	120

Note: This table reports R-squared and t-statistics from OLS regressions between the Conference Board Coincident Indicator year-over-year rate of changes (dependent variable) and leads and lags of the US Capital Markets Portfolio (CMP) log returns volatility (independent). Newey-West Standard Errors are computed. T- statistics are in bold italic. The estimated coefficients are significant at 1% level. If not: ***significant at 5% level; **significant at 10% level; *not significant. Data frequency is on a monthly basis. Regressors are twelve leads and lags (1 year) of 12-month rolling annualised historical volatility of CMP log returns. Annualised historical volatility follows mean-variance calculations of a portfolio with more than one security. CMP is composed by: Equity Market Capitalisation (S&P500), Government Debt Outstandings, Corporate and Financial Debt Outstandings and Total Debt Outstandings up to 1 year maturity. Monthly asset classes weightings in CMP are averages of the last 12-month observations. Equity Market Capitalisation available since Jan/1962. Debt Outstandings available since Dec/1990. Asset classes weightings are constant between Jan/1963 and Dec/1990. Five sub-samples (Jan/1963-Dec/1969; Jan/1970-Dec/1979;Jan/1980-Dec/1989;Jan/1990-Dec/1999 and Jan/2000-Mar/2009) in order to study regime changes between CMP Volatility and the Coincident indicator by decade. Sources: Bloomberg, S&P, BIS.

TABLE 9

PANEL B

CAPITAL MARKETS PORTFOLIO PROXY HISTORICAL VOLATILITY

REGRESSION WITH CAPITAL MARKETS PORTFOLIO VOLATILITY			
	TIME PERIODS		
VOLATILITY LEAD (MONTHS)	31/JAN/1990 - 31/DEC/1999	31/JAN/2000 - 31/MAR/2009	31/JAN/1963 - 31/MAR/2009
+ 12 LEAD	0.06	0.11	0.04
	-1.86 **	***-1.88*** **	***-2.76***
+ 11 LEAD	0.04	0.13	0.05
	-1.58 *	***-1.87*** **	***-3.22***
+ 10 LEAD	0.03	0.14	0.07
	-1.31 *	***-2.04*** ***	***-3.67***
+ 9 LEAD	0.02	0.16	0.09
	-1.09 *	***-2.27*** ***	***-4.02***
+ 8 LEAD	0.01	0.19	0.11
	-0.92 *	***-2.49*** ***	***-4.34***
+ 7 LEAD	0.01	0.21	0.13
	-0.70 *	***-2.77***	***-4.67***
+ 6 LEAD	0.00	0.25	0.16
	-0.49 *	***-3.14***	***-5.01***
+ 5 LEAD	0.00	0.28	0.19
	-0.25 *	***-3.39***	***-5.33***
+ 4 LEAD	0.00	0.32	0.22
	0.00 *	***-3.68***	***-5.68***
+ 3 LEAD	0.00	0.35	0.25
	0.22 *	***-3.86***	***-6.02***
+ 2 LEAD	0.00	0.38	0.28
	0.45 *	***-3.96***	***-6.32***
+ 1 LEAD	0.01	0.41	0.30
	0.66 *	***-4.13***	***-6.53***
CONTEMPORANEOUS	0.01	0.41	0.31
	0.84 *	***-4.12***	***-6.61***
- 1 LAG	0.02	0.39	0.31
	1.00 *	***-4.05***	***-6.59***
- 2 LAG	0.03	0.37	0.29
	1.18 *	***-4.07***	***-6.48***
- 3 LAG	0.04	0.33	0.27
	1.41 *	***-4.09***	***-6.26***
- 4 LAG	0.05	0.29	0.24
	1.62 *	***-4.19***	***-5.92***
- 5 LAG	0.07	0.24	0.21
	1.75 **	***-4.24***	***-5.49***
- 6 LAG	0.08	0.18	0.17
	1.83	***-3.88***	***-4.96***
- 7 LAG	0.09 **	0.17	0.14
	1.77	***-3.54***	***-4.49***
- 8 LAG	0.09	0.15	0.12
	1.67 **	***-3.12***	***-4.01***
- 9 LAG	0.09	0.13	0.09
	1.56 *	***-2.65***	***-3.51***
- 10 LAG	0.08	0.10	0.07
	1.43 *	***-2.16*** ***	***-3.01***
- 11 LAG	0.08	0.08	0.05
	1.38 *	***-1.83*** **	***-2.55*** ***
- 12 LAG	0.08	0.06	0.04
	1.33 *	***-1.64*** *	***-2.12*** ***
Nº OF OBSERVATIONS	120	111	555

Note: This table reports R-squared and t-statistics from OLS regressions between the Conference Board Coincident Indicator year-over-year rate of changes (dependent variable) and leads and lags of the US Capital Markets Portfolio (CMP) log returns volatility (independent). Newey-West Standard Errors are computed. T- statistics are in bold italic. The estimated coefficients are significant at 1% level. If not: ***significant at 5% level; **significant at 10% level; *not significant. Data frequency is on a monthly basis. Regressors are twelve leads and lags (1 year) of 12-month rolling annualised historical volatility of CMP log returns. Annualised historical volatility follows mean-variance calculations of a portfolio with more than one security. CMP is composed by: Equity Market Capitalisation (S&P500), Government Debt Outstandings, Corporate and Financial Debt Outstandings and Total Debt Outstandings up to 1 year maturity. Monthly asset classes weightings in CMP are averages of the last 12-month observations. Equity Market Capitalisation available since Jan/1962. Debt Outstandings available since Dec/1990. Asset classes weightings are constant between Jan/1963 and Dec/1990. Five sub-samples (Jan/1963-Dec/1969; Jan/1970-Dec/1979;Jan/1980-Dec/1989;Jan/1990-Dec/1999 and Jan/2000-Mar/2009) in order to study regime changes between CMP Volatility and the Coincident indicator by decade. Sources: Bloomberg, S&P, BIS.

4.9 ECONOMIC RECESSIONS, EXPANSIONS AND SLOWDOWNS

Besides testing the full interaction between economic growth and financial volatility, it is also important to perform the same tests in different regimes of the economic cycle, as a way of finding if the relationship is more robust in a context of recession periods and of uptrend or downtrend in the rate of economic growth. The NBER is the national U.S. entity that officially determines the chronology of the beginning and ending dates of recessions. According, to the NBER (2008) a recession is a significant decline in economic activity spread across the economy, lasting more than a few months, normally visible in production, employment and real income. A recession begins when the economy reaches a peak of activity and ends when the economy reaches its trough. Furthermore, according to Figure 15, it is possible to see that in every recession period the level of COI always exhibits a break in the long-term upward trend. Furthermore, tests were also performed in downtrend periods of COI YoY, because not only all these periods coincide with an official recession but also, typically, downtrends start before the beginning of the recession period. Thus, I have considered the visible and significant periods of decrease in the year-over-year rate of economic growth. Finally, uptrend periods were also defined by the same rational as for downtrends. Appendix 9 includes the official dates of recessions occurred in the full-sample, considered for the analysis, and also the downtrend and uptrend periods.

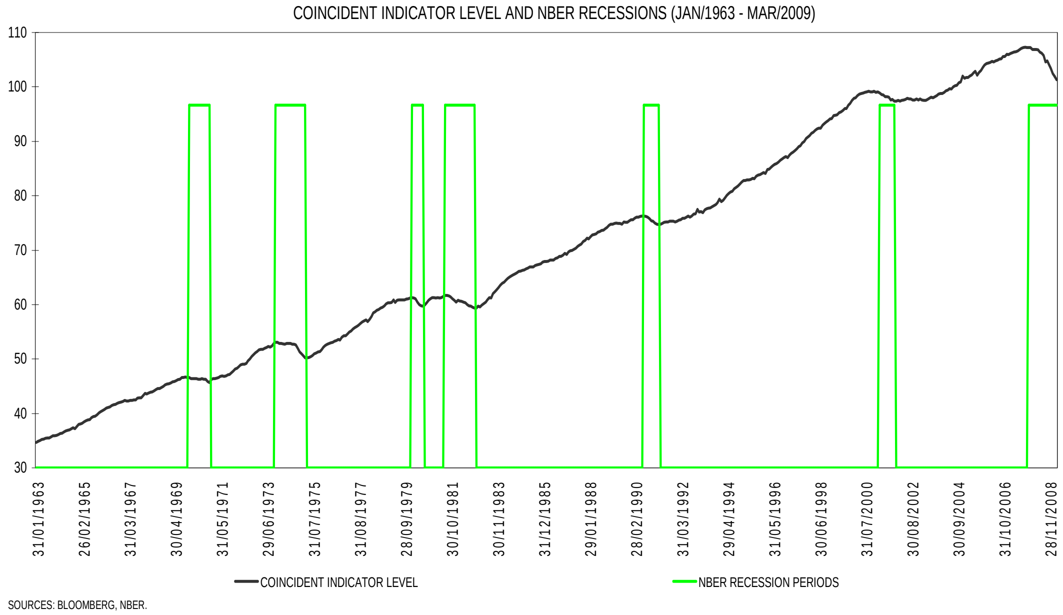


Figure 15: Coincident indicator level and NBER recessions

For all the three regimes of economic growth, were used dummy variables to characterize each monthly observation for being, or not, included in the period defined for the filtered analysis. By creating a new qualitative independent variable, the purpose is to find if the changes in the intercept of the simple model, generated by the coefficient of the binary variable (when = 1), will increase the significance of the relationship between economic growth and financial volatility. Thus, regression models, according to equation (7), were estimated for the full sample period and for all the asset classes and capital markets portfolio proxy volatilities, in the continuous independent variable. Following Schwert (1989), I also tested the models with i lags and leads (i = 3, 6, 9, 12) for the dummy variables. This methodology was justified by the fact that the outcomes of coincident economic variables, dictating recession, expansion or slowdown, usually happen after other leading economic and financial variables start to incorporate expectations about those states of nature. Tables 10 to 24 include the output results of recessions, downtrends and uptrends in COI YoY for the CMP, S&P 500, 3-month t-bill yield, 10yr government bond yield and average Moody's yield spreads volatilities. The results include the following statistics: the estimated coefficients, t-statistics and p-values, for both explanatory variables, R^2 and adjusted R^2 (given the introduction of a new exogenous variable).

4.9.1 *Capital Markets Portfolio Proxy (CMP)*

Results of regressions with CMP volatility as the continuous independent variable are presented in Tables 10, 11 and 12. Most of the estimated coefficients for the lags-leads of the recession dummy variable are negative, meaning that with the occurrence of this state of nature the intercept coefficient of the original regression is adjusted downwards. For the recession scenarios (Table 10) the estimated model with the dummy variable at the coincident level show an adjusted R^2 (or $\overline{R}^2$), of 0.42, higher than the result obtained in the full sample simple model for CMP (0.31, Table 9). It means that with the intercept changed, during recessions, the negative relationship between capital markets volatility and economic growth is statistically more significant. When the dummy lags are considered, meaning a lead of recessions, the results of the estimated models are even more significant, with higher absolute value t-statistics for the binary variable and with the 6th lag producing the highest $\overline{R}^2$ (0.55). With regard to the leads, the results are less statistically significant, with lower R^2 and higher p-values for the dummy variable, as more leads are applied. With leads 6, 9 and 12 the consideration of recessions produces coefficients of determination lower than the simple model and the estimates for the dummy coefficients are not statistically significant. The interpretation is that the inverse relationship of CMP volatility and economic growth is higher in recessions, and that volatility tends to rise well before the beginning of the contraction period.

Results for COI YoY downtrend periods (Table 11) also show that the relationship tends to be more robust when these periods and its lags are considered, with the estimated model with the 9th dummy lag generating the highest $\overline{R}^2$, of 0.52. Although, results for leads are also less robust, than for lags, it is possible to see that the estimated coefficients for the dummy are positive, meaning that the consequent intercept adjustment of the simple regression is in the upside.

Finally, for the COI YoY uptrends (Table 12), results obtained show that these time periods also turn the original relationship more significant, but this occurs when the leads in the uptrend explanatory variable are considered (the highest adjusted $\overline{R}^2$ value is obtained for the 9th lead: with 0.55). Moreover, all the lead estimated coefficients are statistically significant, in opposite to the dummy positive coefficient lags which are not. So, as in recessions and downtrends, the inverse relationship between CMP volatility and COI YoY is higher in uptrends, but in these time periods, the slowdown in volatility is laggard of the rising rate of economic growth. In other words, volatility will only enter in a downward trend once there is evidence or confirmation that the economy is in its phase of expansion.

TABLE 10

CAPITAL MARKETS PORTFOLIO VOLATILITY AND COI YoY - NBER RECESSIONS

REGRESSION WITH CAPITAL MARKETS PORTFOLIO VOLATILITY AND NBER RECESSIONS (JAN/1963-MAR/2009)										
		RECESSION DUMMY VARIABLE: LEADS - LAGS								
EXPLANATORY VARIABLES	REGRESSION STATISTICS	-12	-9	-6	-3	0	+3	+6	+9	+12
CMP VOLATILITY	ESTIMATED COEFFICIENT	-0.31	-0.25	-0.21	-0.23	-0.30	-0.34	-0.36	-0.36	-0.36
(Continuous Variable)	T-STATISTICS	-6.05	-4.91	-4.37	-4.51	-5.32	-5.84	-6.04	-6.22	-6.35
	P-VALUE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
NBER RECESSIONS	ESTIMATED COEFFICIENT	-0.02	-0.03	-0.04	-0.03	-0.02	-0.01	-0.01	0.00	0.00
(Dummy Variable)	T-STATISTICS	-4.51	-7.73	-8.91	-8.09	-5.54	-3.37	-1.84	-0.64	0.50
	P-VALUE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0008	0.0656	0.5224	0.6184
	R-SQUARED	0.4179	0.5204	0.5509	0.5075	0.4220	0.3367	0.2972	0.2914	0.2951
	ADJUSTED R-SQUARED	0.4157	0.5187	0.5492	0.5057	0.4199	0.3343	0.2946	0.2888	0.2925

Note: This table reports output statistics from OLS regressions between the Conference Board Coincident Indicator log returns (dependent variable) and US Capital Markets Portfolio (CMP) log returns volatility and leads and lags of NBER Recessions. CMP volatility consists of 12-month rolling annualised historical volatility of US Capital Markets Portfolio log returns. Annualised historical volatility follows mean-variance calculations of a portfolio with more than one security. NBER Recessions is the qualitative binary variable assuming: 1 - if the observation is in a recession period; 0 - if not. Newey-West standard errors are computed. Data frequency is on a monthly basis. US Capital Markets Portfolio is composed by: Equity Market Capitalisation (S&P500), Government Debt Outstandings, Corporate and Financial Debt Outstandings and Total Debt Outstandings up to 1 year maturity. Monthly Asset Classes weightings in the US Capital Markets Portfolio are averages of the last 12-month observations. Equity Market Capitalisation available since Jan/1962. Debt Outstandings available since Dec/1990. Asset Classes Weightings are constant between Jan/1963 and Dec/1990. NBER recession periods: Dec/69-Nov/70; Nov/73-Mar/75; Jan/80-Jul/80; Jul/81-Nov/82; Jul/90-Mar/91; Mar/01-Nov/01 and Dec/07-... . Sources: Bloomberg, S&P, BIS, NBER.

TABLE 11

CAPITAL MARKETS PORTFOLIO VOLATILITY AND COI YoY - DOWNTRENDS

REGRESSION WITH CAPITAL MARKETS PORTFOLIO VOLATILITY AND COI YoY DOWNTRENDS (JAN/1963-MAR/2009)

		COI YoY DOWNTRENDS DUMMY VARIABLE: LEADS - LAGS								
EXPLANATORY VARIABLES	REGRESSION STATISTICS	-12	-9	-6	-3	0	+3	+6	+9	+12
CMP VOLATILITY	ESTIMATED COEFFICIENT	-0.26	-0.25	-0.27	-0.32	-0.36	-0.38	-0.36	-0.36	-0.36
(Continuous Variable)	T-STATISTICS	-4.79	-5.01	-5.29	-5.72	-6.26	-6.50	-6.49	-6.70	-6.95
	P-VALUE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
COI YoY DOWNTRENDS	ESTIMATED COEFFICIENT	-0.02	-0.03	-0.02	-0.01	-0.01	0.00	0.01	0.01	0.01
(Dummy Variable)	T-STATISTICS	-6.47	-6.98	-5.69	-3.83	-1.49	0.59	1.89	3.15	3.86
	P-VALUE	0.0000	0.0000	0.0000	0.0001	0.1375	0.5536	0.0593	0.0017	0.0001
	R-SQUARED	0.5024	0.5238	0.4656	0.3862	0.3245	0.2973	0.3088	0.3527	0.3836
	ADJUSTED R-SQUARED	0.5006	0.5220	0.4637	0.3839	0.3220	0.2947	0.3063	0.3503	0.3813

Note: This table reports output statistics from OLS regressions between the Conference Board Coincident Indicator log returns (COI YoY) (dependent variable) and US Capital Markets Portfolio (CMP) log returns volatility and leads and lags of COI YoY Downtrends. CMP volatility consists of 12-month rolling annualised historical volatility of US Capital Markets Portfolio log returns. Annualised historical volatility follows mean-variance calculations of a portfolio with more than one security. COI YoY Downtrends is the qualitative binary variable assuming: 1 - if the observation is in a downtrend period; 0 - if not. Newey-West standard errors are computed. Data frequency is on a monthly basis. US Capital Markets Portfolio is composed by: Equity Market Capitalisation (S&P500), Government Debt Outstandings, Corporate and Financial Debt Outstandings and Total Debt Outstandings up to 1 year maturity. Monthly Asset Classes weightings in the US Capital Markets Portfolio are averages of the last 12-month observations. Equity Market Capitalisation available since Jan/1962. Debt Outstandings available since Dec/1990. Asset Classes Weightings are constant between Jan/1963 and Dec/1990. COI YoY downtrend periods: 31/Oct/69-30/Nov/70; 30/Nov/72-31/May/75; 31/Jan/79-31/Jul/80; 31/Jul/81-31/Aug/82; 31/May/84-31/Mar/86; 31/Jan/88-31/Mar/91; 30/Apr/00-31/Dec/01 and 31/Aug/06-31/Mar/09. Sources: Bloomberg, S&P, BIS.

TABLE 12

CAPITAL MARKETS PORTFOLIO VOLATILITY AND COI YoY - UPTRENDS

REGRESSION WITH CAPITAL MARKETS PORTFOLIO VOLATILITY AND COI YoY UPTRENDS (JAN/1963-MAR/2009)

		COI YoY UPTRENDS DUMMY VARIABLE: LEADS - LAGS								
EXPLANATORY VARIABLES	REGRESSION STATISTICS	-12	-9	-6	-3	0	+3	+6	+9	+12
CMP VOLATILITY	ESTIMATED COEFFICIENT	-0.37	-0.37	-0.38	-0.39	-0.38	-0.34	-0.29	-0.27	-0.27
(Continuous Variable)	T-STATISTICS	-6.13	-6.38	-6.66	-6.81	-6.83	-6.78	-6.20	-5.79	-5.30
	P-VALUE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
COI YoY UPTRENDS	ESTIMATED COEFFICIENT	0.01	0.01	0.00	-0.01	-0.01	-0.02	-0.03	-0.03	-0.03
(Dummy Variable)	T-STATISTICS	1.41	1.31	0.30	-1.26	-3.14	-5.40	-7.23	-8.74	-8.87
	P-VALUE	0.1580	0.1903	0.7619	0.2069	0.0018	0.0000	0.0000	0.0000	0.0000
	R-SQUARED	0.322	0.321	0.312	0.320	0.364	0.438	0.508	0.549	0.539
	ADJUSTED R-SQUARED	0.319	0.318	0.309	0.318	0.361	0.436	0.506	0.547	0.537

Note: This table reports output statistics from OLS regressions between the Conference Board Coincident Indicator log returns (COI YoY) (dependent variable) and US Capital Markets Portfolio (CMP) log returns volatility and leads and lags of COI YoY Uptrends. CMP volatility consists of 12-month rolling annualised historical volatility of US Capital Markets Portfolio log returns. Annualised historical volatility follows mean-variance calculations of a portfolio with more than one security. COI YoY Uptrends is the qualitative binary variable assuming: 1 - if the observation is in an uptrend period; 0 - if not. Newey-West standard errors are computed. Data frequency is on a monthly basis. Conference Board Coincident Indicator data is available since 31/Jan/1959. US Capital Markets Portfolio data is available since January 1963. US Capital Markets Portfolio is composed by: Equity Market Capitalisation (S&P500), Government Debt Outstandings, Corporate and Financial Debt Outstandings and Total Debt Outstandings up to 1 year maturity. Monthly Asset Classes weightings in the US Capital Markets Portfolio are averages of the last 12-month observations. Equity Market Capitalisation available since Jan/1962. Debt Outstandings available since Dec/1990. Asset Classes Weightings are constant between Jan/1963 and Dec/1990. COI YoY uptrend periods: 30/Nov/70-30/Nov/72; 31/May/75-30/Apr/76; 31/Oct/82-31/Mar/84; 31/Mar/91-31/Jan/95; 31/Dec/01-31/Dec/04. Sources: Bloomberg, S&P, BIS.

4.9.2 *Equity*

In the case of S&P 500 volatility, the estimated regressions also show that with the introduction of a dummy variable the three states of nature considered improve the statistical results (Tables 13, 14 and 15). When recession periods are considered (Table 13), the $\overline{R}^2$ obtained with the binary variable, at the contemporaneous level, improve to 0.36, from 0.18 in the original regression (Table

2). With lags applied to the dummy, the estimated coefficients are all negative and statistically significant at 1% level. Moreover the $\overline{R}^2$ values are higher, with the 6th lag producing the highest adjusted coefficient of determination, of 0.51. However, when leads are considered, not only the R^2 are increasingly lower, but also the dummy estimated coefficients decrease its statistical significance.

In the case of a downtrend in growth regime (Table 14), the profile of results is similar, with dummy lags producing the best regression results (in the 9th lag $\overline{R}^2$ achieves the highest value: 0.48). With leads applied to downtrends, the $\overline{R}^2$ values are lower than its corresponding lags, and the estimated coefficients for dummies are always positive (9th and 12th leads are also statistically significant at 1% level). When compared to the recession regime, results imply that in downward trend periods the quality of the regression adjustment is lower. Additionally, given that the highest $\overline{R}^2$ in downtrends is obtained at the 9th lag, in comparison with the 6th lag during recessions, when an economic downtrend period is eminent, volatility starts to rise before than it does in recession environments.

Finally, in the case of uptrend scenarios (Table 15), volatility interacts better with growth when leads are applied to the dummy independent variable. The corresponding estimated coefficients are negative, statistically significant at 1% level and the better fit is achieved at the 9th lead, with the $\overline{R}^2$ being 0.47. By this, equity volatility tends to increase well in advance before the real recession or downtrend are in place and tends to lag the economic recovery, lowering its level when the uptrend in growth is already taking its course.

TABLE 13

EQUITY VOLATILITY AND COI YoY - NBER RECESSIONS

REGRESSION WITH S&P 500 VOLATILITY AND NBER RECESSIONS (JAN/1963-MAR/2009)

		RECESSION DUMMY VARIABLE: LEADS - LAGS								
EXPLANATORY VARIABLES	REGRESSION STATISTICS	-12	-9	-6	-3	0	+3	+6	+9	+12
S&P 500 VOLATILITY	ESTIMATED COEFFICIENT	-0.15	-0.11	-0.10	-0.11	-0.15	-0.18	-0.18	-0.19	-0.18
(Continuous Variable)	T-STATISTICS	-3.21	-2.80	-2.56	-2.63	-2.99	-3.25	-3.33	-3.38	-3.36
	P-VALUE	0.0014	0.0052	0.0109	0.0088	0.0029	0.0012	0.0009	0.0008	0.0008
NBER RECESSIONS	ESTIMATED COEFFICIENT	-0.03	-0.04	-0.04	-0.04	-0.03	-0.02	-0.01	0.00	0.00
(Dummy Variable)	T-STATISTICS	-5.17	-8.90	-10.36	-8.93	-6.03	-3.84	-2.21	-0.95	0.19
	P-VALUE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0274	0.3415	0.8480
	R-SQUARED	0.3349	0.4658	0.5130	0.4720	0.3626	0.2495	0.1944	0.1787	0.1771
	ADJUSTED R-SQUARED	0.3324	0.4638	0.5112	0.4701	0.3602	0.2468	0.1915	0.1757	0.1741

Note: This table reports output statistics from OLS regressions between the Conference Board Coincident Indicator log returns (dependent variable) and S&P 500 log returns volatility and leads and lags of NBER Recessions. S&P 500 volatility consists of 12-month rolling annualised historical volatility of log returns. NBER Recessions is the qualitative binary variable assuming: 1 - if the observation is in a recession period; 0 - if not. Newey-West standard errors are computed. Data frequency is on a monthly basis. NBER recession periods: Dec/69-Nov/70; Nov/73-Mar/75; Jan/80-Jul/80; Jul/81-Nov/82; Jul/90-Mar/91; Mar/01-Nov/01 and Dec/07-... . Sources: Bloomberg, NBER.

TABLE 14

EQUITY VOLATILITY AND COI YoY - DOWNTRENDS

REGRESSION WITH CAPITAL S&P 500 VOLATILITY AND COI YoY DOWNTRENDS (JAN/1963-MAR/2009)

		COI YoY DOWNTRENDS DUMMY VARIABLE: LEADS - LAGS								
EXPLANATORY VARIABLES	REGRESSION STATISTICS	-12	-9	-6	-3	0	+3	+6	+9	+12
S&P 500 VOLATILITY	ESTIMATED COEFFICIENT	-0.12	-0.13	-0.14	-0.16	-0.19	-0.19	-0.19	-0.19	-0.19
(Continuous Variable)	T-STATISTICS	-2.94	-3.18	-3.09	-3.14	-3.35	-3.52	-3.61	-3.76	-3.86
	P-VALUE	0.0034	0.0016	0.0021	0.0018	0.0009	0.0005	0.0003	0.0002	0.0001
COI YoY DOWNTRENDS	ESTIMATED COEFFICIENT	-0.03	-0.03	-0.02	-0.02	-0.01	0.00	0.01	0.01	0.01
(Dummy Variable)	T-STATISTICS	-7.58	-8.04	-6.55	-4.57	-2.12	0.36	1.87	3.14	3.64
	P-VALUE	0.0000	0.0000	0.0000	0.0000	0.0341	0.7165	0.0624	0.0018	0.0003
	R-SQUARED	0.4458	0.4811	0.4151	0.3187	0.2261	0.1832	0.1987	0.2436	0.2681
	ADJUSTED R-SQUARED	0.4438	0.4792	0.4130	0.3162	0.2261	0.1802	0.1958	0.2408	0.2654

Note: This table reports output statistics from OLS regressions between the Conference Board Coincident Indicator log returns (COI YoY) (dependent variable) and S&P 500 log returns volatility and leads and lags of COI YoY Downtrends. S&P 500 volatility consists of 12-month rolling annualised historical volatility of S&P 500 returns. COI YoY Downtrends is the qualitative binary variable assuming: 1 - if the observation is in a downtrend period; 0 - if not. Newey-West standard errors are computed. Data frequency is on a monthly basis. COI YoY downtrend periods: 31/Oct/69-30/Nov/70; 30/Nov/72-31/May/75; 31/Jan/79-31/Jul/80; 31/Jul/81-31/Aug/82; 31/May/84-31/Mar/86; 31/Jan/88-31/Mar/91; 30/Apr/00-31/Dec/01 and 31/Aug/06-31/Mar/09. Sources: Bloomberg.

TABLE 15

EQUITY VOLATILITY AND COI YoY - UPTRENDS

REGRESSION WITH CAPITAL S&P 500 VOLATILITY AND COI YoY UPTRENDS (JAN/1963-MAR/2009)

		COI YoY UPTRENDS DUMMY VARIABLE: LEADS - LAGS								
EXPLANATORY VARIABLES	REGRESSION STATISTICS	-12	-9	-6	-3	0	+3	+6	+9	+12
S&P 500 VOLATILITY	ESTIMATED COEFFICIENT	-0.19	-0.19	-0.20	-0.21	-0.20	-0.17	-0.14	-0.12	-0.12
(Continuous Variable)	T-STATISTICS	-3.24	-3.41	-3.62	-3.77	-3.82	-3.66	-3.35	-2.98	-2.64
	P-VALUE	0.0013	0.0007	0.0003	0.0002	0.0002	0.0003	0.0009	0.0003	0.0086
COI YoY UPTRENDS	ESTIMATED COEFFICIENT	0.01	0.01	0.00	-0.01	-0.01	-0.02	-0.03	-0.03	-0.03
(Dummy Variable)	T-STATISTICS	1.44	1.28	0.20	-1.35	-3.28	-5.64	-7.45	-8.64	-8.39
	P-VALUE	0.1509	0.2000	0.8427	0.1781	0.0011	0.0000	0.0000	0.0000	0.0000
	R-SQUARED	0.2133	0.2116	0.2025	0.2107	0.2539	0.3404	0.4264	0.4729	0.4645
	ADJUSTED R-SQUARED	0.2104	0.2087	0.1996	0.2078	0.2512	0.3380	0.4243	0.4709	0.4625

Note: This table reports output statistics from OLS regressions between the Conference Board Coincident Indicator log returns (COI YoY) (dependent variable) and S&P 500 log returns volatility and leads and lags of COI YoY Uptrends. S&P 500 volatility consists of 12-month rolling annualised historical volatility of S&P 500 returns. COI YoY Uptrends is the qualitative binary variable assuming: 1 - if the observation is in an uptrend period; 0 - if not. Newey-West standard errors are computed. Data frequency is on a monthly basis.COI YoY uptrend periods: 30/Nov/70-30/Nov/72; 31/May/75-30/Apr/76; 31/Oct/82-31/Mar/84; 31/Mar/91-31/Jan/95; 31/Dec/01-31/Dec/04. Sources: Bloomberg.

4.9.3 *Money Markets*

The three economic regimes improve the results from the original regressions, when the 3-month yield volatility is considered (Tables 16, 17 and 18). The outputs for recessions (Table 16) and downtrends (Table 17) show that with lags applied to the dummy variable the R^2 values are higher than at the lag zero and leads, its estimated coefficients are negative and p-values are statistically significant at 1.00% level. However, the highest R^2 are obtained with different lags. In recessions, the highest adjusted coefficient of determination (0.48) is obtained at lag 6 and in downtrends it is lag 9 that produces the higher $\bar{R}^2$, of 0.45. A distinct feature from the recession state of nature is that after lag 6 the R^2 obtained are lower as a higher lag is applied to the model.

In the case of dummy leads, for recession periods the quality of adjustment is not improved, as the results obtained, for leads 3, 6, 9 and 12 show lower $\bar{R}^2$ than in the original regression (Table 4). However, in downtrend periods, leads 9 and 12 improve the results from the simple model, with $\bar{R}^2$ of 0.32 and 0.34 (respectively) and estimated coefficients of the dummy positive are statistically significant at 1% level. This way, in recessions and downtrends, not only the inverse relationship between 3-month yield volatility and COI YoY is improved but also volatility tends to rise in advance to the opposite pattern in economic growth. Moreover, volatility also tends to rise with a substantial lag (leads 9 and 12) to the economic downtrend.

In uptrend periods (Table 18), results are improved when leads are considered for the dummy variable. The coincident level and leads (3, 6, 9 and 12) produce substantially higher R^2 values than in the original model, with the highest adjusted one, of 0.55, occurring at lead 9. The estimated coefficients of the uptrend qualitative variable are all negative and significant at 1.00% level.

Thus, 3 month yield volatility tends to drift lower after the economic expansion is confirmed, by the uptrend in the year-over-year rate of economic growth.

TABLE 16

MONEY MARKETS VOLATILITY AND COI YoY - NBER RECESSIONS

REGRESSION WITH 3-MONTH T-BILL YIELD VOLATILITY AND NBER RECESSIONS (JAN/1963-MAR/2009)

		RECESSION DUMMY VARIABLE: LEADS - LAGS								
EXPLANATORY VARIABLES	REGRESSION STATISTICS	-12	-9	-6	-3	0	+3	+6	+9	+12
3-MONTH YIELD VOLATILITY	ESTIMATED COEFFICIENT	-0.65	-0.41	-0.30	-0.37	-0.60	-0.82	-0.92	-0.96	-0.99
(Continuous Variable)	T-STATISTICS	-4.64	-2.55	-2.42	-2.60	-3.36	-4.47	-5.17	-5.85	-6.46
	P-VALUE	0.0000	0.0110	0.0157	0.0096	0.0008	0.0000	0.0000	0.0000	0.0000
NBER RECESSIONS	ESTIMATED COEFFICIENT	-0.03	-0.04	-0.04	-0.04	-0.03	-0.01	0.00	0.01	0.01
(Dummy Variable)	T-STATISTICS	-4.66	-7.89	-9.66	-8.10	-4.71	-2.09	-0.23	1.04	2.04
	P-VALUE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0369	0.8144	0.2984	0.0414
	R-SQUARED	0.3217	0.4428	0.4904	0.4430	0.3307	0.2499	0.2302	0.2364	0.2549
	ADJUSTED R-SQUARED	0.3192	0.4408	0.4885	0.4409	0.3282	0.2472	0.2274	0.2336	0.2522

Note: This table reports output statistics from OLS regressions between the Conference Board Coincident Indicator log returns (dependent variable) and 3-month T-Bill yield volatility and leads and lags of NBER Recessions. 3-month yield volatility consists of 12-month rolling annualized realized volatility of absolute changes of T-Bills yields. NBER Recessions is the qualitative binary variable assuming: 1 - if the observation is in a recession period; 0 - if not. Newey-West standard errors are computed. Data frequency is on a monthly basis. NBER recession periods: Dec/69-Nov/70; Nov/73-Mar/75; Jan/80-Jul/80; Jul/81-Nov/82; Jul/90-Mar/91; Mar/01-Nov/01 and Dec/07-... . Sources: Bloomberg, NBER.

TABLE 17

MONEY MARKETS VOLATILITY AND COI YoY - DOWNTRENDS

REGRESSION WITH CAPITAL 3-MONTH T-BILL YIELD VOLATILITY AND COI YoY DOWNTRENDS (JAN/1963-MAR/2009)

		COI YoY DOWNTRENDS DUMMY VARIABLE: LEADS - LAGS								
EXPLANATORY VARIABLES	REGRESSION STATISTICS	-12	-9	-6	-3	0	+3	+6	+9	+12
3-MONTH YIELD VOLATILITY	ESTIMATED COEFFICIENT	-0.50	-0.47	-0.57	-0.71	-0.71	-0.96	-0.98	-0.97	-0.97
(Continuous Variable)	T-STATISTICS	-2.74	-2.95	-4.16	-4.88	-4.88	-5.56	-6.06	-6.80	-7.08
	P-VALUE	0.0064	0.0033	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
COI YoY DOWNTRENDS	ESTIMATED COEFFICIENT	-0.03	-0.03	-0.02	-0.02	-0.02	0.00	0.01	0.01	0.02
(Dummy Variable)	T-STATISTICS	-6.44	-6.91	-5.81	-3.93	-3.93	0.81	2.58	3.80	4.37
	P-VALUE	0.0000	0.0000	0.0000	0.0001	0.0001	0.4184	0.0102	0.0002	0.0000
	R-SQUARED	0.4324	0.4534	0.3970	0.3105	0.3105	0.2315	0.2735	0.3203	0.3441
	ADJUSTED R-SQUARED	0.4303	0.4513	0.3947	0.3079	0.3079	0.2287	0.2708	0.3178	0.3417

Note: This table reports output statistics from OLS regressions between the Conference Board Coincident Indicator log returns (dependent variable) and 3-month T-Bill yield volatility and leads and lags of COI YoY Dowtrends. 3-month yield volatility consists of 12-month rolling annualized realized volatility of absolute changes of T-Bills yields. COI YoY Downtrend is the qualitative binary variable assuming: 1 - if the observation is in a downtrend period; 0 - if not. Newey-West standard errors are computed. Data frequency is on a monthly basis. COI downtrend periods: 31/Oct/69-30/Nov/70; 30/Nov/72-31/May/75; 31/Jan/79-31/Jul/80; 31/Jul/81-31/Aug/82; 31/May/84-31/Mar/86; 31/Jan/88-31/Mar/91; 30/Apr/00-31/Dec/01 and 31/Aug/06-31/Mar/09. Sources: Bloomberg.

TABLE 18

MONEY MARKETS VOLATILITY AND COI YoY - UPTRENDS

REGRESSION WITH CAPITAL 3-MONTH T-BILL YIELD VOLATILITY AND COI YoY UPTRENDS (JAN/1963-MAR/2009)

		COI YoY UPTRENDS DUMMY VARIABLE: LEADS - LAGS								
EXPLANATORY VARIABLES	REGRESSION STATISTICS	-12	-9	-6	-3	0	+3	+6	+9	+12
3-MONTH YIELD VOLATILITY	ESTIMATED COEFFICIENT	-0.87	-0.89	-0.93	-0.95	-0.95	-0.89	-0.81	-0.75	-0.75
(Continuous Variable)	T-STATISTICS	-5.07	-5.23	-5.54	-5.84	-6.39	-7.50	-8.46	-7.41	-5.64
	P-VALUE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
COI YoY UPTRENDS	ESTIMATED COEFFICIENT	0.01	0.01	0.00	-0.01	-0.01	-0.02	-0.03	-0.03	-0.03
(Dummy Variable)	T-STATISTICS	1.77	1.31	0.37	-1.07	-3.02	-5.51	-7.69	-9.23	-9.37
	P-VALUE	0.0780	0.1984	0.7117	0.2865	0.0026	0.0000	0.0000	0.0000	0.0000
	R-SQUARED	0.2376	0.2283	0.2161	0.2243	0.2794	0.4079	0.5120	0.5500	0.5388
	ADJUSTED R-SQUARED	0.2347	0.2255	0.2133	0.2215	0.2768	0.4058	0.5102	0.5484	0.5371

Note: This table reports output statistics from OLS regressions between the Conference Board Coincident Indicator log returns (dependent variable) and 3-month T-Bill yield volatility and leads and lags of COI YoY Uptrends. 3-month yield volatility consists of 12-month rolling annualized realized volatility of absolute changes of T-Bills yields. COI YoY Uptrend is the qualitative binary variable assuming: 1 - if the observation is in an Uptrend period; 0 - if not. Newey-West standard errors are computed. Data frequency is on a monthly basis. COI uptrend periods: 30/Nov/70-30/Nov/72; 31/May/75-30/Apr/76; 31/Oct/82-31/Mar/84; 31/Mar/91-31/Jan/95; 31/Dec/01-31/Dec/04. Sources: Bloomberg.

4.9.4 *Government Debt*

In terms of long term bond yields volatility (Tables 19, 20 and 21), the inclusion of dummy variables reflecting recessions (Table 19) and downtrends (Table 20) generates an improvement in the goodness-of-fit of the original estimated model. In case of recessions, the adjusted R-squared is 0.34 for the contemporaneous level, much higher than the one obtained in the original model (0.18, Table 5). When considering lags 3 to 9 months, the adjustment gets even more significant, with the 6th lag in recession periods showing a $\overline{R}^2$ of 0.52. The outputs for the leads are less significant with the $\overline{R}^2$ values being substantially lower. All the estimated coefficients for the dummy variable are negative, with the exception of the 12th lead, and statistically significant at 1% level, with the exception of the 6th and 12th leads. In downtrend scenarios, the profile is similar. However, at the coincident dummy level, the goodness-of-fit is lower than the one from recessions ($\overline{R}^2$ = 0.21) but yet higher than the original model. With lags applied to the downtrend dummy variable, statistical results are improved with higher $\overline{R}^2$ values, and the estimated coefficient of dummy variables being significant at 1% level. If in recessions the best fit is achieved at the 6th lag, in case of downtrend periods the 10yr volatility and economic growth inverse relationship is best improved ($\overline{R}^2$ = 0.46) when 9 lags are considered. When the model is estimated with leads for downtrend periods, the fit is much lower and the dummy estimated coefficients being positive imply an upward adjustment in the intercept of the original regression. However, some of them are not statistically significant.

In the uptrend regime (Table 21), once again financial volatility is laggard of economic growth, with the 9th and 12th leads for the binary variable producing the highest $\overline{R}^2$ values, of 0.49 and 0.48 respectively. At the coincident level of the dummy variable, statistical results are similar to the ones obtained in the downtrend regime, and when lags are considered the statistical significance is also lower. Only the 12th lag for the dummy variable generates an estimated coefficient that is statistically significant at 1% level.

Once more, in the case of 10yr yield, rising financial volatility leads the rate of economic growth, both in recessions and downturns. Additionally, in environments of economic recovery or expansions the reduction in 10yr yield volatility tends to be laggard.

TABLE 19

GOVERNMENT DEBT VOLATILITY AND COI YoY - NBER RECESSIONS

REGRESSION WITH 10YR YIELD VOLATILITY AND NBER RECESSIONS (JAN/1963-MAR/2009)

		RECESSION DUMMY VARIABLE: LEADS - LAGS								
EXPLANATORY VARIABLES	REGRESSION STATISTICS	-12	-9	-6	-3	0	+3	+6	+9	+12
10YR YIELD VOLATILITY	ESTIMATED COEFFICIENT	-1.39	-1.11	-0.93	-0.95	-1.26	-1.54	-1.67	-1.46	-1.75
(Continuous Variable)	T-STATISTICS	-4.43	-3.54	-3.34	-3.35	-4.39	-5.23	-5.65	-5.02	-6.14
	P-VALUE	0.0000	0.0004	0.0009	0.0009	0.0000	0.0000	0.0000	0.0000	0.0000
NBER RECESSIONS	ESTIMATED COEFFICIENT	-0.03	-0.04	-0.04	-0.04	-0.03	-0.02	-0.01	-0.02	0.00
(Dummy Variable)	T-STATISTICS	-4.11	-7.25	-8.56	-7.85	-5.59	-3.32	-1.65	-3.94	0.90
	P-VALUE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0010	0.1002	0.0001	0.3710
	R-SQUARED	0.3286	0.4716	0.5168	0.4619	0.3401	0.2290	0.1891	0.2561	0.1889
	ADJUSTED R-SQUARED	0.3261	0.4696	0.5150	0.4599	0.3377	0.2262	0.1861	0.2534	0.1859

Note: This table reports output statistics from OLS regressions between the Conference Board Coincident Indicator log returns (dependent variable) and 10yr yield volatility and leads and lags of NBER Recessions. 10yr yield volatility consists of 12-month rolling annualized realized volatility of absolute changes of 10yr government bonds yields. NBER Recessions is the qualitative binary variable assuming: 1 - if the observation is in a recession period; 0 - if not. Newey-West standard errors are computed. Data frequency is on a monthly basis. NBER recession periods: Dec/69-Nov/70; Nov/73-Mar/75; Jan/80-Jul/80; Jul/81-Nov/82; Jul/90-Mar/91; Mar/01-Nov/01 and Dec/07-... . Sources: Bloomberg, NBER.

TABLE 20

GOVERNMENT DEBT VOLATILITY AND COI YoY - DOWNTRENDS

REGRESSION WITH 10YR YIELD VOLATILITY AND COI YoY DOWNTRENDS (JAN/1963-MAR/2009)

		COI YoY DOWNTRENDS DUMMY VARIABLE: LEADS - LAGS								
EXPLANATORY VARIABLES	REGRESSION STATISTICS	-12	-9	-6	-3	0	+3	+6	+9	+12
10YR YIELD VOLATILITY	ESTIMATED COEFFICIENT	-1.07	-1.04	-1.18	-1.38	-1.64	-1.74	-1.73	-1.72	-1.76
(Continuous Variable)	T-STATISTICS	-2.90	-3.20	-3.86	-4.44	-5.37	-6.07	-6.30	-6.63	-6.88
	P-VALUE	0.0039	0.0015	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
COI YoY DOWNTRENDS	ESTIMATED COEFFICIENT	-0.03	-0.03	-0.03	-0.02	-0.01	0.00	0.01	0.01	0.01
(Dummy Variable)	T-STATISTICS	-6.00	-6.40	-5.43	-3.69	-1.96	0.16	1.79	3.11	3.87
	P-VALUE	0.0000	0.0000	0.0000	0.0001	0.0505	0.8720	0.0744	0.0020	0.0001
	R-SQUARED	0.4375	0.4613	0.3990	0.3002	0.2079	0.1757	0.2001	0.2471	0.2774
	ADJUSTED R-SQUARED	0.4354	0.4593	0.3968	0.2976	0.2051	0.1727	0.1971	0.2443	0.2748

Note: This table reports output statistics from OLS regressions between the Conference Board Coincident Indicator log returns (dependent variable) and 10yr yield volatility and leads and lags of COI YoY Dowtrends. 10yr yield volatility consists of 12-month rolling annualized realized volatility of absolute changes of 10yr government bonds yields. COI YoY Downtrend is the qualitative binary variable assuming: 1 - if the observation is in a downtrend period; 0 - if not. Newey-West standard errors are computed. Data frequency is on a monthly basis. COI downtrend periods: 31/Oct/69-30/Nov/70; 30/Nov/72-31/May/75; 31/Jan/79-31/Jul/80; 31/Jul/81-31/Aug/82; 31/May/84-31/Mar/86; 31/Jan/88-31/Mar/91; 30/Apr/00-31/Dec/01 and 31/Aug/06-31/Mar/09. Sources: Bloomberg.

TABLE 21

GOVERNMENT DEBT VOLATILITY AND COI YoY - UPTRENDS

REGRESSION WITH CAPITAL 10YR YIELD VOLATILITY AND COI YoY UPTRENDS (JAN/1963-MAR/2009)

		COI YoY UPTRENDS DUMMY VARIABLE: LEADS - LAGS								
EXPLANATORY VARIABLES	REGRESSION STATISTICS	-12	-9	-6	-3	0	+3	+6	+9	+12
10YR YIELD VOLATILITY	ESTIMATED COEFFICIENT	-1.79	-1.82	-1.83	-1.80	-1.70	-1.48	-1.31	-1.25	-1.27
(Continuous Variable)	T-STATISTICS	-6.02	-6.26	-6.25	-6.12	-5.87	-5.28	-4.69	-4.74	-4.76
	P-VALUE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
COI YoY UPTRENDS	ESTIMATED COEFFICIENT	0.01	0.01	0.01	0.00	-0.01	-0.02	-0.03	-0.03	-0.03
(Dummy Variable)	T-STATISTICS	2.75	2.44	1.40	-0.27	-2.31	-4.43	-5.98	-7.34	-8.15
	P-VALUE	0.0061	0.0151	0.1623	0.7840	0.0213	0.0000	0.0000	0.0000	0.0000
	R-SQUARED	0.2298	0.2203	0.1928	0.1799	0.2175	0.3243	0.4355	0.4928	0.4829
	ADJUSTED R-SQUARED	0.2270	0.2174	0.1899	0.1769	0.2146	0.3218	0.4334	0.4909	0.4810

Note: This table reports output statistics from OLS regressions between the Conference Board Coincident Indicator log returns (dependent variable) and 10yr yield volatility and leads and lags of COI YoY Uptrends. 10yr yield volatility consists of 12-month rolling annualized realized volatility of absolute changes of government bonds yields. COI YoY Uptrend is the qualitative binary variable assuming: 1 - if the observation is in an Uptrend period; 0 - if not. Newey-West standard errors are computed. Data frequency is on a monthly basis. COI uptrend periods: 30/Nov/70-30/Nov/72; 31/May/75-30/Apr/76; 31/Oct/82-31/Mar/84; 31/Mar/91-31/Jan/95; 31/Dec/01-31/Dec/04. Sources: Bloomberg.

4.9.5 *Corporate and Financial Debt*

The results for this asset class, using the average Moody's yield spread as the proxy, also show an improvement when the three economic states are considered via new independent dummy variable (Tables 22, 23 and 24). In recessions (Table 22), results with the dummy variable being coincident substantially improve the ones obtained in the original model. The new $\overline{R}^2$ value, of 0.31, compares with 0.15 in the simple regression (Table 8). In the estimated regressions with lags for recessions, $\overline{R}^2$ are higher and all the estimated coefficients are statistically significant at 1% level. The best fit is at lag 6, with the adjusted R-squared reaching 0.50. In the case of leads, the adjusted measure, with the exception of lead 3, is lower than the original model and, thus, not incorporating new valuable recession information.

In downtrends (Table 23), the contemporaneous regression shows a much lower $\overline{R}^2$ value (0.17) when compared to the recession regime results. In the same vein, the goodness-of-fit is better with lags, than leads, applied to growth downtrends. All the estimated coefficients for downtrends lags are negative with p-values lower than 1%. The highest $\overline{R}^2$ (0.44) is obtained at the 9th lag applied to the dummy variable. For leads in downtrends, results are less significant and only lead

9 and 12 produce significant results and $\overline{R}^2$ values slightly higher than the ones in the original regression.

Finally, in uptrend contexts (Table 24), the inclusion of a binary variable also increases the significance of the original regression, with a $\overline{R}^2$ value of 0.20, and when leads are considered the most statistically significant fits are obtained. Leads 9 and 12 generate the highest absolute t-statistics values for the dummy variable and the highest adjusted R-square, of 0.46 and 045, respectively. With the introduction of lags, the significance of regressions results is always lower than the ones resulting from the contemporaneous levels.

Hence, a rise in corporate and credit spreads volatility also lead recessions and downturns, but a falling trend in variability will lag the economy uptrend rate of growth.

TABLE 22

CORPORATE AND FINANCIAL DEBT VOLATILITY AND COI YoY - NBER RECESSIONS

REGRESSION WITH AVERAGE MOODY´s YIELD SPREAD VOLATILITY AND NBER RECESSIONS (JAN/1963-MAR/2009)

		RECESSION DUMMY VARIABLE: LEADS - LAGS								
EXPLANATORY VARIABLES	REGRESSION STATISTICS	-12	-9	-6	-3	0	+3	+6	+9	+12
YIELD SPREAD VOLATILITY	ESTIMATED COEFFICIENT	-1.34	-1.02	-0.82	-0.88	-1.24	-1.54	-1.70	-1.79	-1.82
(Continuous Variable)	T-STATISTICS	-3.16	-2.67	-2.59	-2.68	-3.43	-3.97	-4.34	-4.72	-4.88
	P-VALUE	0.0016	0.0078	0.0099	0.0076	0.0006	0.0001	0.0000	0.0000	0.0000
NBER RECESSIONS	ESTIMATED COEFFICIENT	-0.03	-0.04	-0.04	-0.04	-0.03	-0.02	-0.01	0.00	0.00
(Dummy Variable)	T-STATISTICS	-4.26	-7.86	-9.36	-8.54	-5.87	-3.15	-1.37	-0.13	0.89
	P-VALUE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0017	0.1720	0.8950	0.3747
	R-SQUARED	0.2943	0.4467	0.4972	0.4445	0.3149	0.1888	0.1421	0.1378	0.1439
	ADJUSTED R-SQUARED	0.2916	0.4447	0.4953	0.4424	0.3125	0.1859	0.1390	0.1346	0.1408

Note: This table reports output statistics from OLS regressions between the Conference Board Coincident Indicator log returns (dependent variable) and average Moody´s yield spreads volatility and leads and lags of NBER Recessions. Spreads volatiltiy volatility consists of 12-month rolling annualized realized volatility of absolute changes of average Moody´s yield spreads. NBER Recessions is the qualitative binary variable assuming: 1 - if the observation is in a recession period; 0 - if not. Newey-West standard errors are computed. Data frequency is on a monthly basis. NBER recession periods: Dec/69-Nov/70; Nov/73-Mar/75; Jan/80-Jul/80; Jul/81-Nov/82; Jul/90-Mar/91; Mar/01-Nov/01 and Dec/07-... . Sources: Bloomberg, NBER.

TABLE 23

CORPORATE AND FINANCIAL DEBT VOLATILITY AND COI YoY - DOWNTRENDS

REGRESSION WITH AVERAGE MOODY´s YIELD SPREAD VOLATILITY AND COI YoY DOWNTRENDS (JAN/1963-MAR/2009)

		COI YoY DOWNTRENDS DUMMY VARIABLE: LEADS - LAGS								
EXPLANATORY VARIABLES	REGRESSION STATISTICS	-12	-9	-6	-3	0	+3	+6	+9	+12
YIELD SPREAD VOLATILITY	ESTIMATED COEFFICIENT	-1.06	-1.04	-1.17	-1.40	-1.73	-1.86	-1.84	-1.85	-1.87
(Continuous Variable)	T-STATISTICS	-2.38	-2.74	-3.32	-3.73	-4.37	-4.95	-5.33	-5.64	-5.49
	P-VALUE	0.0175	0.0064	0.0010	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000
COI YoY DOWNTRENDS	ESTIMATED COEFFICIENT	-0.03	-0.03	-0.03	-0.02	-0.01	0.00	0.01	0.01	0.02
(Dummy Variable)	T-STATISTICS	-6.46	-6.91	-5.76	-4.07	-1.82	0.42	2.04	3.29	3.90
	P-VALUE	0.0000	0.0000	0.0000	0.0001	0.0693	0.6767	0.0417	0.0011	0.0001
	R-SQUARED	0.4208	0.4468	0.3784	0.2733	0.1761	0.1387	0.1634	0.2123	0.2387
	ADJUSTED R-SQUARED	0.4187	0.4448	0.3761	0.2706	0.1731	0.1356	0.1603	0.2094	0.2358

Note: This table reports output statistics from OLS regressions between the Conference Board Coincident Indicator log returns (dependent variable) and average Moody´s yield spreads volatility and leads and lags of COI YoY Dowtrends. Spreads volatility consists of 12-month rolling annualized realized volatility of absolute changes of average Moody´s yield spreads. COI YoY Downtrend is the qualitative binary variable assuming: 1 - if the observation is in a downtrend period; 0 - if not. Newey-West standard errors are computed. Data frequency is on a monthly basis. COI downtrend periods: 31/Oct/69-30/Nov/70; 30/Nov/72-31/May/75; 31/Jan/79-31/Jul/80; 31/Jul/81-31/Aug/82; 31/May/84-31/Mar/86; 31/Jan/88-31/Mar/91; 30/Apr/00-31/Dec/01 and 31/Aug/06-31/Mar/09. Sources: Bloomberg.

TABLE 24

CORPORATE AND FINANCIAL DEBT VOLATILITY AND COI YoY - UPTRENDS

REGRESSION WITH AVERAGE MOODY´s YIELD SPREAD VOLATILITY AND COI YoY UPTRENDS (JAN/1963-MAR/2009)

		COI YoY UPTRENDS DUMMY VARIABLE: LEADS - LAGS								
EXPLANATORY VARIABLES	REGRESSION STATISTICS	-12	-9	-6	-3	0	+3	+6	+9	+12
YIELD SPREAD VOLATILITY	ESTIMATED COEFFICIENT	-1.85	-1.90	-1.95	-1.96	-1.88	-1.59	-1.38	-1.28	-1.26
(Continuous Variable)	T-STATISTICS	-4.60	-4.88	-5.07	-5.09	-4.89	-4.36	-3.93	-3.80	-3.64
	P-VALUE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0002	0.0003
COI YoY UPTRENDS	ESTIMATED COEFFICIENT	0.01	0.01	0.00	0.00	-0.01	-0.02	-0.03	-0.03	-0.03
(Dummy Variable)	T-STATISTICS	2.22	1.90	0.97	-0.56	-2.56	-4.83	-6.52	-7.77	-8.33
	P-VALUE	0.0270	0.0581	0.3341	0.5750	0.0108	0.0000	0.0000	0.0000	0.0000
	R-SQUARED	0.1876	0.1794	0.1583	0.1534	0.1990	0.3038	0.4156	0.4691	0.4549
	ADJUSTED R-SQUARED	0.1846	0.1764	0.1553	0.1503	0.1961	0.3013	0.4135	0.4672	0.4528

Note: This table reports output statistics from OLS regressions between the Conference Board Coincident Indicator log returns (dependent variable) and average Moody´s yield spreads volatility and leads and lags of COI YoY Uptrends. Spreads volatility consists of 12-month rolling annualized realized volatility of absolute changes of government bonds yields. COI YoY Uptrend is the qualitative binary variable assuming: 1 - if the observation is in an Uptrend period; 0 - if not. Newey-West standard errors are computed. Data frequency is on a monthly basis. COI uptrend periods: 30/Nov/70-30/Nov/72; 31/May/75-30/Apr/76; 31/Oct/82-31/Mar/84; 31/Mar/91-31/Jan/95; 31/Dec/01-31/Dec/04. Sources: Bloomberg.

4.9.6 *Results Comparison*

Figure 16: Adjusted R^2 in NBER recessions

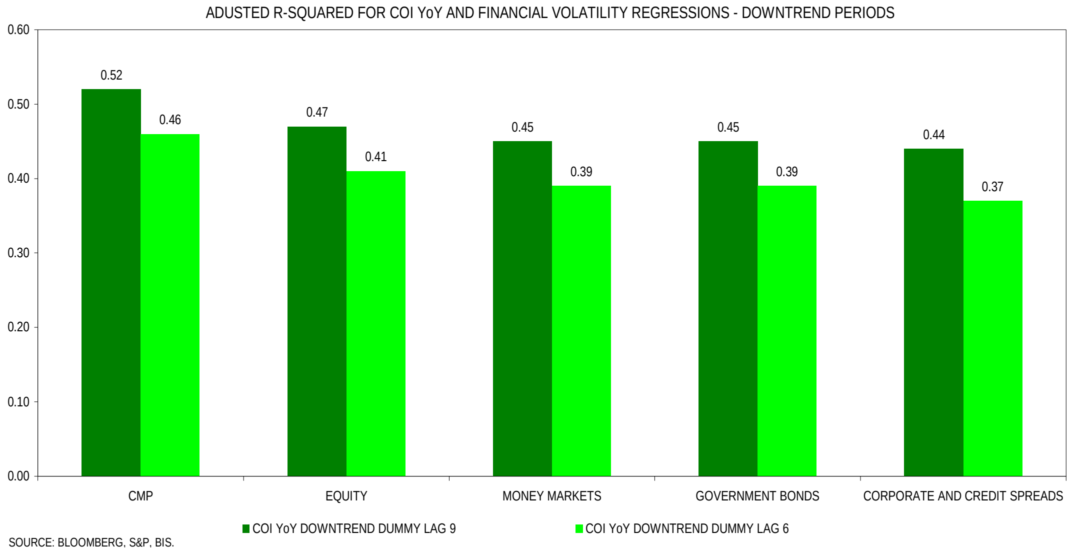


Figure 17: Adjusted R^2 in COI YoY downtrends

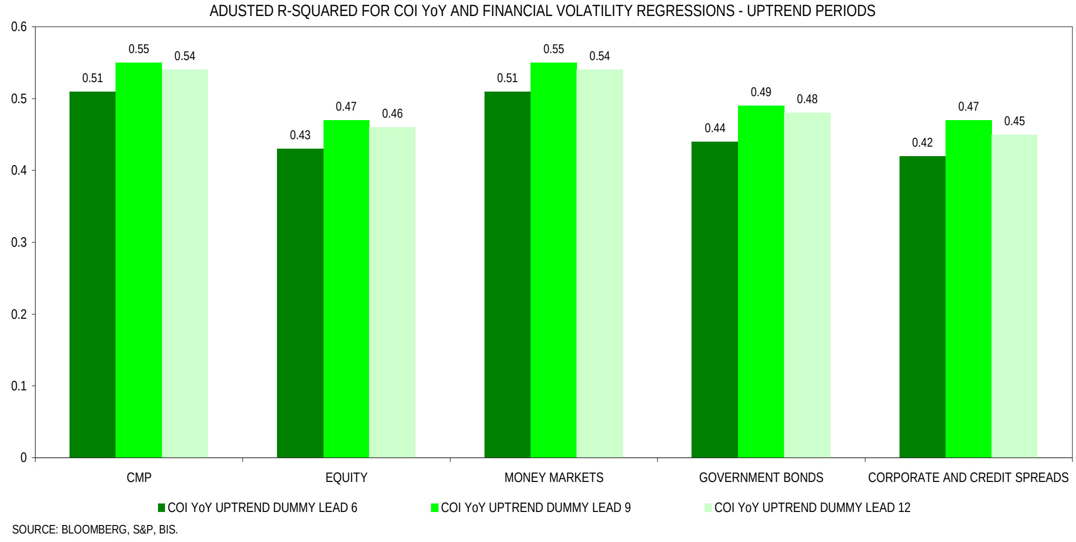


Figure 18: Adjusted R^2 in COI YoY uptrends

Figures 16, 17 and 18 show that, with the introduction of a dummy variable, characterizing three different types of economic junctures, there is an improvement in the statistical results of the original models, for the capital markets portfolio and for the individual asset classes' volatilities. That improvement in the goodness-of-fit occurs mainly when the dummy variable is contemporaneous, when lags are considered, in recessions and downturn periods, and when leads are applied in uptrend periods of economic growth.

For both CMP and asset classes, the best lead results of recessions are achieved at lag 6 while in downtrend periods the highest $\overline{R}^2$ values are generated at lag 9, meaning that financial volatility rise more in advance of downturns than of recessions. Both in recessions and downtrend periods, CMP volatility shows the highest adjusted R-square value. In recessions, money markets volatility and credit spreads show the lowest coefficients of determination. In downtrends, money markets, government bonds and corporate spreads exhibit the low end levels of $\overline{R}^2$.

With regard to the uptrend economic regime, the best results occur at lead 9 of the dummy variable, in spite of adjusted R-square values being very similar in leads 6 to 12. Thus, financial volatility tends to go down after the economic upturn is confirmed. CMP and equity volatility show the highest fit and corporate spreads the lowest one. Overall, CMP volatility, being a proxy for the U.S. capital markets variability, is better correlated with COI YoY when different growth regimes are explicitly considered in the statistical analysis.

5 CONCLUSION

This thesis aims to find an empirical relationship between capital markets volatility and the rate of real economic growth, for the United States. In this vein, the empirical study focused on how to measure the interaction between individual markets (or asset classes) volatilities and growth, on a single basis and also at an aggregate level (developing a proxy for the U.S. capital markets) and considering a long time span enough to encompass different economic and capital markets cycles. The period considered for all the analysis was from January 31, 1963 to March 31, 2009.

An important restriction was the fact that economic data is of low frequency and the release of the U.S. real GDP is only on a quarterly basis. Given the high frequency of financial data and consequently of volatility (e.g. daily), trying to establish a quantitative relationship based on quarterly data would raise the probability of loosing valuable information in terms of assets volatility patterns. This way, I had to research for other economic indicators, released on a monthly basis, that should be strongly and contemporaneously correlated with GDP. The indicator that best fitted the criteria was the Conference Board Coincident Indicator.

In terms of volatility metrics, I considered the 12-month rolling historical calculation, given the lack of availability of implied volatility measures for the asset classes considered in this study (with the exception of equities).

Then, for each market not only were performed standard OLS regressions based on the entire period, but also sample partitions were considered given structural economic and financial changing regimes or specific events within asset classes, occurring in the full-sample. In addition to this, when analysing the dynamics between the capital markets proxy and the economic growth proxy, I also considered a set of sub-periods based on each decade in order to find the possible changes in the relationship of the two variables across time.

In the case of equities volatility, I have found a statistically significant negative relationship with growth with a slightly leading bias of volatility, given the results obtained. Thus, results imply that an upward trend in equity volatility has a small lead in the slow down of the year-over-year rate of economic growth. For the entire period and sub-periods analysed (January, 1963 - September, 1987 and October, 1988 - March, 2009) the relationship is more robust when the sample from January, 1963 to September, 1987 is considered.

For the money, government bond and corporate and financial bond markets volatilities, OLS results show a strong contemporaneous, and negative, significant relationship with economic growth, until December, 1984. Thereafter, with the emergence of the *Great Moderation* of the economy and gradualism of monetary policies, the volatility of interest rates structurally lost cyclicality and, consequently, also explanatory power of economic growth, from January, 1985 onwards. However, the results for the entire period also show a statistically significant relationship implying that volatilities of these asset classes are negatively correlated with growth. Regressions were also performed considering the volatility of the U.S. yield curve changes, and results obtained were statistically more significant. In the period of January, 1985 to March, 2009 the yield curve variability had explanatory power of economic growth.

With regard to the capital markets portfolio proxy (CMP), the output of regressions, for the entire period, show that its volatility has better explanatory power that any individual market in explaining U.S. economic growth, with the most statistically significant results obtained at the contemporaneous level. As for the individual asset classes, in average, a positive (negative) increase in historical volatility of CMP generates a negative (positive) impact in the year-over-year rate of economic growth. Moreover, regression results from each decade show that: in the 1960s there was a leading pattern of CMP volatility in economic growth; in 1970 decade volatility and growth were strongly negatively correlated; in the 1980s a similar pattern to the prior decade was found albeit not so highly correlated; in the

1990 decade there was no statistically significant relationship; and in the period from January, 2000 to March, 2009 the correlation pattern between CMP volatility and economic growth was similar to the one find in the full period and sample of the 1980 decade.

When considering only states of nature corresponding to official recessions, economic downtrends and uptrends, regression results are improved showing a highly explanatory power of individual assets and COI volatilities in growth. In fact, financial volatility tends to rise in advance of the beginning of a recession, or an economic slowdown, (leading) and typically enters into a downward trend after the beginning of an economic expansion period (lagging). In other words, this filtered analysis shows that rising financial volatility could be a trigger of economic downturns and, when it is falling, could be a consequence of economic expansions.

Finally, and since that in the Finance field any quantitative analysis could always be enriched, in my view the basis of this thesis could be extended to analyse the interactions between capital markets volatilities and growth, in other geographical blocs, and the interaction between U.S. capital markets and the rate of growth of other economies. In the case of the U.S., it would also be an important subject to study these dynamics considering specific aggregates of private domestic demand, like household consumption and investment, interacting with financial volatility.

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APPENDIX 1

U.S. REAL GDP PROXIES CROSS-CORRELATIONS

Cross Correlogram of REAL_YOY and COI_END_Q

Date: 07/24/09 Time: 19:53
Sample: 1960Q1 2009Q1
Included observations: 197
Correlations are asymptotically consistent approximations

REAL_YOY,COI_END_Q(-i) REAL_YOY,COI_END_Q(+i)

i	lag	lead
0	0.9108	0.9108
1	0.7408	0.8094
2	0.5066	0.6746
3	0.2731	0.4843
4	0.0744	0.2791
5	-0.0532	0.1156
6	-0.1095	-0.0139
7	-0.1357	-0.0955
8	-0.1483	-0.1323
9	-0.1539	-0.1293
10	-0.1662	-0.1179
11	-0.1802	-0.1187
12	-0.2024	-0.1186
13	-0.2003	-0.1181
14	-0.1817	-0.1263
15	-0.1423	-0.1166
16	-0.0864	-0.0977
17	-0.0481	-0.0702
18	-0.0178	-0.0289
19	-0.0044	0.0064
20	-0.0063	0.0274
21	-0.0097	0.0310
22	-0.0190	0.0237
23	-0.0355	0.0112
24	-0.0382	0.0022
25	-0.0181	-0.0177
26	0.0054	-0.0394
27	0.0260	-0.0553
28	0.0469	-0.0474
29	0.0436	-0.0151
30	0.0295	0.0278
31	0.0154	0.0577
32	-0.0256	0.0357
33	-0.0691	0.0076
34	-0.1075	-0.0364
35	-0.1319	-0.0823
36	-0.1212	-0.0992

Cross Correlogram of REAL_YOY and ISM_END_Q

Date: 07/24/09 Time: 20:12
Sample: 1 238
Included observations: 238
Correlations are asymptotically consistent approximations

REAL_YOY,ISM_END_Q(-i) REAL_YOY,ISM_END_Q(+i)

i	lag	lead
0	0.6500	0.6500
1	0.7464	0.3867
2	0.6629	0.1447
3	0.4702	-0.0197
4	0.1947	-0.1339
5	-0.0489	-0.1742
6	-0.1769	-0.1462
7	-0.1901	-0.1120
8	-0.1629	-0.0790
9	-0.1037	-0.0568
10	-0.0366	-0.0951
11	-0.0185	-0.1284
12	-0.0372	-0.1393
13	-0.0813	-0.1157
14	-0.1265	-0.0483
15	-0.1445	0.0146
16	-0.0837	0.0700
17	0.0176	0.0865
18	0.1055	0.0746
19	0.1450	0.0524
20	0.1188	0.0355
21	0.0587	0.0250
22	-0.0066	0.0240
23	-0.0398	0.0237
24	-0.0373	0.0140
25	-0.0270	-0.0089
26	0.0111	-0.0319
27	0.0424	-0.0374
28	0.0380	-0.0241
29	0.0126	-0.0079
30	-0.0453	0.0228
31	-0.1005	0.0501
32	-0.1363	0.0426
33	-0.1222	0.0487
34	-0.0945	0.0215
35	-0.0685	-0.0195
36	-0.0383	-0.0431

Cross Correlogram of REAL_YOY and CFNAI_END_Q

Date: 07/24/09 Time: 20:30
Sample: 1 170
Included observations: 169
Correlations are asymptotically consistent approximations

REAL_YOY,CFNAI_END_ REAL_YOY,CFNAI_END_

i	lag	lead
0	0.5977	0.5977
1	0.7183	0.4081
2	0.6218	0.2349
3	0.4808	0.1109
4	0.2807	-0.0315
5	0.0422	-0.1358
6	-0.0714	-0.1738
7	-0.1116	-0.1725
8	-0.1491	-0.1603
9	-0.1883	-0.1517
10	-0.2207	-0.1749
11	-0.2331	-0.2056
12	-0.2163	-0.2025
13	-0.2098	-0.1761
14	-0.2251	-0.1583
15	-0.2330	-0.1217
16	-0.2050	-0.0471
17	-0.1383	0.0476
18	-0.0332	0.1030
19	0.0401	0.1040
20	0.0683	0.0781
21	0.1083	0.0383
22	0.1434	-0.0110
23	0.1279	-0.0420
24	0.0904	-0.0673
25	0.0315	-0.1108
26	-0.0115	-0.0988
27	-0.0093	-0.0301
28	0.0303	0.0211
29	0.0507	0.0611
30	0.0533	0.0817
31	0.0559	0.0534
32	0.0581	0.0019
33	0.0420	-0.0319
34	-0.0184	-0.0609
35	-0.0487	-0.0802
36	-0.0931	-0.0759

APPENDIX 2

U.S. CAPITAL MARKETS PORTFOLIO PROXY

US CAPITAL MARKETS OUTSTANDINGS (in Billions of US dollars)*

DATE	EQUITY MARKET CAPITALISATION**	GOVERNMENT DEBT***	CORPORATES + FINANCIALS DEBT***	DEBT UP TO ONE YEAR****	TOTAL OUTSTANDINGS
31/Dez/89	$2,141	$2,837	$3,762	$1,709	***$10,449***
31/Dez/90	$2,046	$3,131	$4,039	$1,847	***$11,063***
31/Dez/91	$2,777	$3,491	$4,296	$1,920	***$12,484***
31/Dez/92	$3,032	$3,791	$4,556	$1,976	***$13,355***
31/Dez/93	$3,366	$4,083	$4,890	$2,054	***$14,392***
31/Mar/94	$3,239	$4,131	$5,001	$2,060	***$14,432***
30/Jun/94	$3,232	$4,133	$5,109	$2,050	***$14,524***
30/Set/94	$3,400	$4,158	$5,220	$2,089	***$14,866***
31/Dez/94	$3,401	$4,176	$5,360	$2,163	***$15,100***
31/Mar/95	$3,744	$4,258	$5,466	$2,253	***$15,721***
30/Jun/95	$4,102	$4,279	$5,615	$2,280	***$16,277***
30/Set/95	$4,444	$4,261	$5,773	$2,322	***$16,801***
31/Dez/95	$4,755	$4,295	$5,915	$2,352	***$17,316***
31/Mar/96	$5,036	$4,356	$6,021	$2,442	***$17,855***
30/Jun/96	$5,329	$4,333	$6,205	$2,455	***$18,321***
30/Set/96	$5,535	$4,380	$6,334	$2,519	***$18,768***
31/Dez/96	$5,933	$4,424	$6,502	$2,607	***$19,466***
31/Mar/97	$6,085	$4,470	$6,612	$2,694	***$19,861***
30/Jun/97	$7,177	$4,412	$6,806	$2,687	***$21,082***
30/Set/97	$7,929	$4,421	$6,925	$2,762	***$22,037***
31/Dez/97	$8,240	$4,456	$7,149	$2,849	***$22,694***
31/Mar/98	$9,474	$4,485	$7,424	$2,999	***$24,381***
30/Jun/98	$9,866	$4,408	$7,636	$2,941	***$24,852***
30/Set/98	$9,000	$4,386	$7,851	$3,001	***$24,238***
31/Dez/98	$11,240	$4,434	$8,081	$3,081	***$26,836***
31/Mar/99	$11,953	$4,466	$8,346	$3,173	***$27,938***
30/Jun/99	$12,767	$4,368	$8,520	$3,105	***$28,760***
30/Set/99	$11,875	$4,353	$8,711	$3,177	***$28,116***
31/Dez/99	$13,875	$4,404	$8,995	$3,466	***$30,740***
31/Mar/00	$14,459	$4,386	$9,144	$3,575	***$31,565***
30/Jun/00	$14,604	$4,204	$9,293	$3,528	***$31,629***
30/Set/00	$14,603	$4,122	$9,464	$3,570	***$31,759***
31/Dez/00	$12,944	$4,106	$9,633	$3,702	***$30,384***
31/Mar/01	$11,798	$4,178	$9,854	$3,691	***$29,521***
30/Jun/01	$12,510	$4,048	$9,994	$3,507	***$30,059***
30/Set/01	$10,606	$4,118	$10,132	$3,572	***$28,428***
31/Dez/01	$11,853	$4,204	$10,378	$3,638	***$30,073***
31/Mar/02	$11,915	$4,276	$10,575	$3,672	***$30,438***
30/Jun/02	$10,337	$4,339	$10,651	$3,574	***$28,901***
30/Set/02	$8,656	$4,438	$10,766	$3,578	***$27,439***
31/Dez/02	$9,172	$4,544	$10,985	$3,598	***$28,299***
31/Mar/03	$9,010	$4,697	$11,264	$3,695	***$28,665***
30/Jun/03	$10,431	$4,799	$11,471	$3,694	***$30,395***
30/Set/03	$10,757	$4,886	$11,644	$3,704	***$30,990***
31/Dez/03	$12,023	$5,024	$11,677	$3,791	***$32,515***
31/Mar/04	$12,308	$5,205	$11,873	$3,939	***$33,325***
30/Jun/04	$12,463	$5,285	$12,120	$4,054	***$33,921***
30/Set/04	$12,216	$5,387	$12,374	$3,977	***$33,954***
31/Dez/04	$13,345	$5,529	$12,655	$4,107	***$35,637***
31/Mar/05	$13,061	$5,721	$12,938	$4,263	***$35,984***
30/Jun/05	$13,259	$5,702	$13,239	$4,231	***$36,430***
30/Set/05	$13,640	$5,789	$13,430	$4,406	***$37,264***
31/Dez/05	$13,934	$5,918	$13,839	$4,652	***$38,343***
31/Mar/06	$14,475	$6,100	$14,225	$4,906	***$39,705***
30/Jun/06	$14,132	$6,063	$14,576	$4,885	***$39,656***
30/Set/06	$14,696	$6,135	$14,960	$5,076	***$40,866***
31/Dez/06	$15,606	$6,230	$15,279	$5,181	***$42,296***
31/Mar/07	$15,630	$6,411	$15,744	$5,353	***$43,139***
30/Jun/07	$16,484	$6,342	$15,993	$5,321	***$44,141***
30/Set/07	$16,724	$6,471	$16,380	$5,278	***$44,852***
31/Dez/07	$15,921	$6,592	$16,711	$5,404	***$44,628***
31/Mar/08	$14,291	$6,809	$16,801	$5,608	***$43,509***
30/Jun/08	$14,015	$6,790	$16,814	$5,447	***$43,066***
30/Set/08	$12,539	$7,324	$16,840	$5,781	***$42,483***
31/Dez/08	$9,568	$7,888	$16,733	$5,969	***$40,159***

* US Capital Markets outstandings considering the following Asset Classes: Equities, Government Debt, Corporate and Financial Debt and Short Term Debt (Governments, Corporates and Financials);

** Equity Market Capitalisation of S&P 500. Source: S&P;

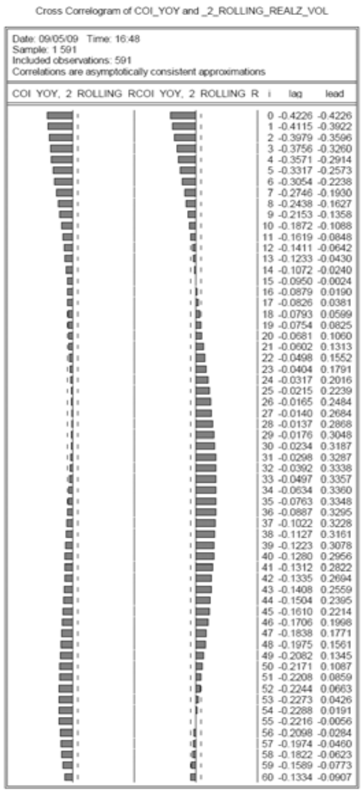
*** Outstanding Domestic Debt Securities. Source: BIS Quarterly Review Jun/2009;

**** Outstanding Domestic Debt Securities of Governments, Corporates and Financials Issuers with remaining maturity up to one year. Source: BIS Quarterly Review Jun/200

APPENDIX 3

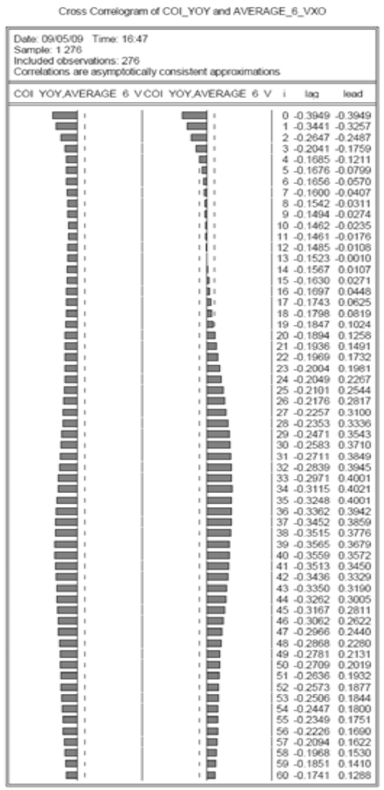
ASSET CLASSES AND COI YoY CROSS-CORRELATIONS

PANEL A - S&P 500 VOLATILITY



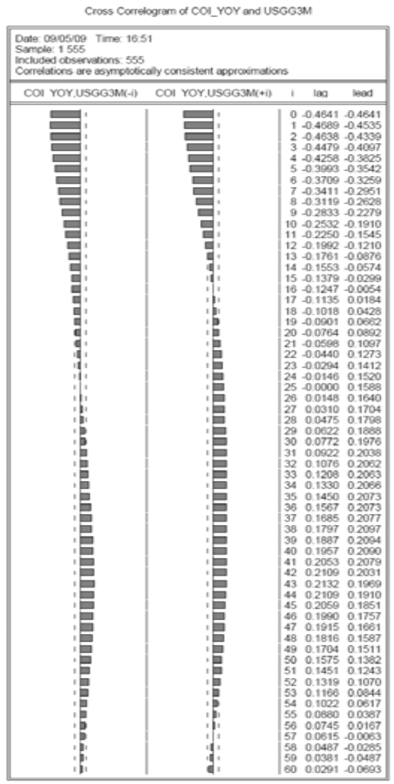
i	lag	lead
0	-0.4226	-0.4226
1	-0.4115	-0.3922
2	-0.3979	-0.3596
3	-0.3756	-0.3260
4	-0.3571	-0.2914
5	-0.3317	-0.2573
6	-0.3054	-0.2238
7	-0.2746	-0.1930
8	-0.2438	-0.1627
9	-0.2153	-0.1358
10	-0.1872	-0.1088
11	-0.1619	-0.0848
12	-0.1411	-0.0642
13	-0.1233	-0.0430
14	-0.1072	-0.0240
15	-0.0950	-0.0024
16	-0.0879	0.0190
17	-0.0826	0.0381
18	-0.0793	0.0599
19	-0.0754	0.0825
20	-0.0681	0.1060
21	-0.0602	0.1313
22	-0.0498	0.1552
23	-0.0404	0.1791
24	-0.0317	0.2016
25	-0.0215	0.2239
26	-0.0165	0.2484
27	-0.0140	0.2684
28	-0.0137	0.2868
29	-0.0176	0.3048
30	-0.0234	0.3187
31	-0.0298	0.3287
32	-0.0392	0.3338
33	-0.0497	0.3357
34	-0.0634	0.3360
35	-0.0763	0.3348
36	-0.0887	0.3295
37	-0.1022	0.3228
38	-0.1127	0.3161
39	-0.1223	0.3078
40	-0.1280	0.2956
41	-0.1312	0.2822
42	-0.1335	0.2694
43	-0.1408	0.2559
44	-0.1504	0.2395
45	-0.1610	0.2214
46	-0.1706	0.1998
47	-0.1838	0.1771
48	-0.1975	0.1561
49	-0.2082	0.1345
50	-0.2171	0.1087
51	-0.2208	0.0859
52	-0.2244	0.0663
53	-0.2273	0.0426
54	-0.2288	0.0191
55	-0.2216	-0.0056
56	-0.2098	-0.0284
57	-0.1974	-0.0460
58	-0.1822	-0.0623
59	-0.1589	-0.0773
60	-0.1334	-0.0907

PANEL B - VIX



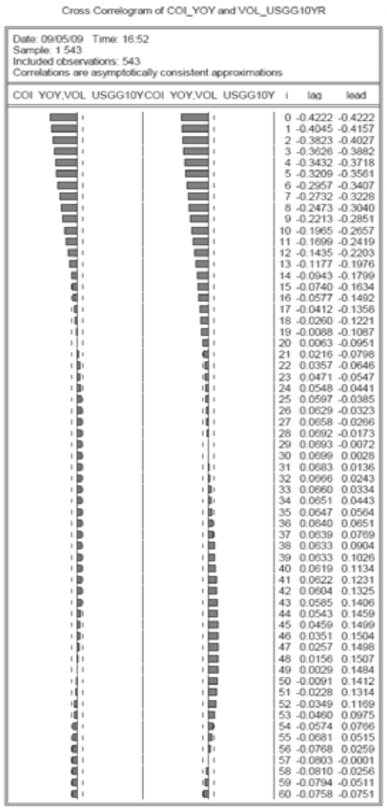
i	lag	lead
0	-0.3949	-0.3949
1	-0.3441	-0.3257
2	-0.2647	-0.2487
3	-0.2041	-0.1759
4	-0.1685	-0.1211
5	-0.1676	-0.0799
6	-0.1656	-0.0570
7	-0.1600	-0.0407
8	-0.1542	-0.0311
9	-0.1494	-0.0274
10	-0.1462	-0.0235
11	-0.1461	-0.0176
12	-0.1485	-0.0108
13	-0.1523	-0.0010
14	-0.1567	0.0107
15	-0.1630	0.0271
16	-0.1697	0.0448
17	-0.1743	0.0625
18	-0.1798	0.0819
19	-0.1847	0.1024
20	-0.1894	0.1258
21	-0.1936	0.1491
22	-0.1969	0.1732
23	-0.2004	0.1981
24	-0.2049	0.2267
25	-0.2101	0.2544
26	-0.2176	0.2817
27	-0.2257	0.3100
28	-0.2353	0.3336
29	-0.2471	0.3543
30	-0.2583	0.3710
31	-0.2711	0.3849
32	-0.2839	0.3945
33	-0.2971	0.4001
34	-0.3115	0.4021
35	-0.3248	0.4001
36	-0.3362	0.3942
37	-0.3452	0.3859
38	-0.3515	0.3776
39	-0.3565	0.3679
40	-0.3559	0.3572
41	-0.3513	0.3450
42	-0.3436	0.3329
43	-0.3350	0.3190
44	-0.3262	0.3005
45	-0.3167	0.2811
46	-0.3062	0.2622
47	-0.2966	0.2440
48	-0.2868	0.2280
49	-0.2781	0.2131
50	-0.2709	0.2019
51	-0.2636	0.1932
52	-0.2573	0.1877
53	-0.2506	0.1844
54	-0.2447	0.1800
55	-0.2349	0.1751
56	-0.2226	0.1690
57	-0.2094	0.1622
58	-0.1968	0.1530
59	-0.1851	0.1410
60	-0.1741	0.1288

PANEL C - 3-MONTH YIELD



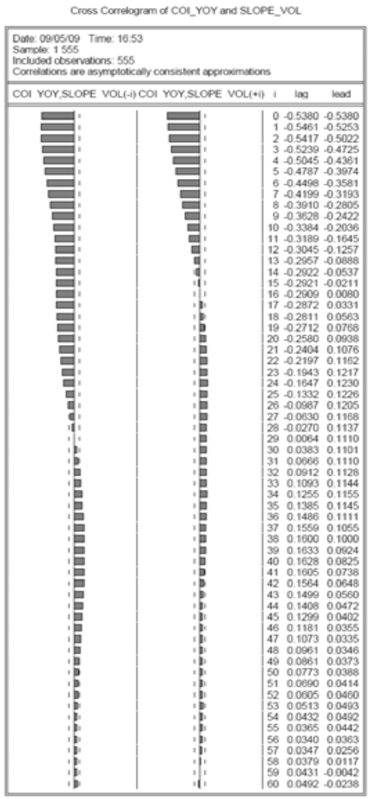
i	lag	lead
0	-0.4641	-0.4641
1	-0.4689	-0.4535
2	-0.4638	-0.4339
3	-0.4479	-0.4097
4	-0.4258	-0.3825
5	-0.3993	-0.3542
6	-0.3709	-0.3259
7	-0.3411	-0.2951
8	-0.3119	-0.2628
9	-0.2833	-0.2279
10	-0.2532	-0.1910
11	-0.2250	-0.1545
12	-0.1992	-0.1210
13	-0.1761	-0.0876
14	-0.1553	-0.0574
15	-0.1379	-0.0299
16	-0.1247	-0.0054
17	-0.1135	0.0184
18	-0.1018	0.0428
19	-0.0901	0.0662
20	-0.0764	0.0892
21	-0.0598	0.1097
22	-0.0440	0.1273
23	-0.0294	0.1412
24	-0.0146	0.1520
25	-0.0000	0.1588
26	0.0148	0.1640
27	0.0310	0.1704
28	0.0475	0.1798
29	0.0622	0.1888
30	0.0772	0.1976
31	0.0922	0.2038
32	0.1076	0.2062
33	0.1208	0.2063
34	0.1330	0.2066
35	0.1450	0.2073
36	0.1567	0.2073
37	0.1685	0.2077
38	0.1797	0.2097
39	0.1887	0.2094
40	0.1957	0.2090
41	0.2053	0.2079
42	0.2109	0.2031
43	0.2132	0.1969
44	0.2109	0.1910
45	0.2059	0.1851
46	0.1990	0.1757
47	0.1915	0.1661
48	0.1816	0.1587
49	0.1704	0.1511
50	0.1575	0.1382
51	0.1451	0.1243
52	0.1319	0.1070
53	0.1166	0.0844
54	0.1022	0.0617
55	0.0880	0.0387
56	0.0745	0.0167
57	0.0615	-0.0063
58	0.0487	-0.0285
59	0.0381	-0.0487
60	0.0291	-0.0693

PANEL D - 10YR YIELD



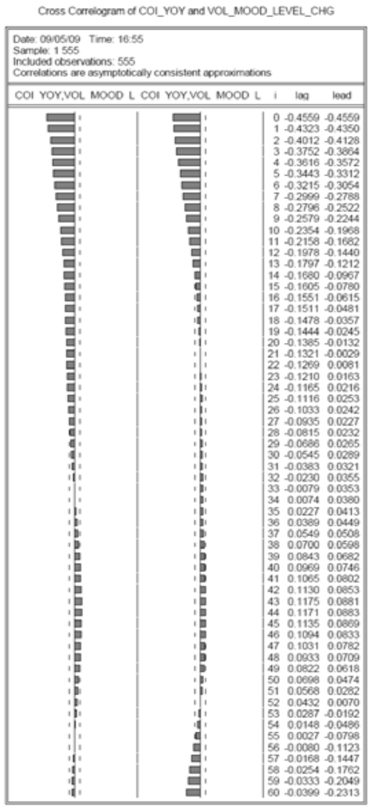
i	lag	lead
0	-0.4222	-0.4222
1	-0.4045	-0.4157
2	-0.3823	-0.4027
3	-0.3626	-0.3882
4	-0.3432	-0.3718
5	-0.3209	-0.3561
6	-0.2957	-0.3407
7	-0.2732	-0.3228
8	-0.2473	-0.3040
9	-0.2213	-0.2851
10	-0.1965	-0.2657
11	-0.1699	-0.2419
12	-0.1435	-0.2203
13	-0.1177	-0.1976
14	-0.0943	-0.1799
15	-0.0740	-0.1634
16	-0.0577	-0.1492
17	-0.0412	-0.1358
18	-0.0260	-0.1221
19	-0.0088	-0.1087
20	0.0063	-0.0951
21	0.0216	-0.0798
22	0.0357	-0.0646
23	0.0471	-0.0547
24	0.0548	-0.0441
25	0.0597	-0.0385
26	0.0629	-0.0323
27	0.0658	-0.0266
28	0.0692	-0.0173
29	0.0693	-0.0072
30	0.0699	0.0028
31	0.0683	0.0136
32	0.0666	0.0243
33	0.0660	0.0334
34	0.0651	0.0443
35	0.0647	0.0564
36	0.0640	0.0651
37	0.0639	0.0769
38	0.0633	0.0904
39	0.0633	0.1026
40	0.0619	0.1134
41	0.0622	0.1231
42	0.0604	0.1325
43	0.0585	0.1406
44	0.0543	0.1459
45	0.0459	0.1499
46	0.0351	0.1504
47	0.0257	0.1498
48	0.0156	0.1507
49	0.0029	0.1484
50	-0.0091	0.1412
51	-0.0228	0.1314
52	-0.0349	0.1169
53	-0.0460	0.0975
54	-0.0574	0.0766
55	-0.0681	0.0515
56	-0.0768	0.0259
57	-0.0803	-0.0001
58	-0.0810	-0.0256
59	-0.0794	-0.0511
60	-0.0758	-0.0751

PANEL E - 10 - 3 CURVE



i	lag	lead
0	-0.5380	-0.5380
1	-0.5461	-0.5253
2	-0.5417	-0.5022
3	-0.5239	-0.4725
4	-0.5045	-0.4361
5	-0.4787	-0.3974
6	-0.4498	-0.3581
7	-0.4199	-0.3193
8	-0.3910	-0.2805
9	-0.3628	-0.2422
10	-0.3384	-0.2036
11	-0.3189	-0.1645
12	-0.3045	-0.1257
13	-0.2957	-0.0888
14	-0.2922	-0.0537
15	-0.2921	-0.0211
16	-0.2909	0.0080
17	-0.2872	0.0331
18	-0.2811	0.0563
19	-0.2712	0.0768
20	-0.2580	0.0938
21	-0.2404	0.1076
22	-0.2197	0.1162
23	-0.1943	0.1217
24	-0.1647	0.1230
25	-0.1332	0.1226
26	-0.0987	0.1205
27	-0.0630	0.1168
28	-0.0270	0.1137
29	0.0064	0.1110
30	0.0383	0.1101
31	0.0666	0.1110
32	0.0912	0.1128
33	0.1093	0.1144
34	0.1255	0.1155
35	0.1385	0.1145
36	0.1486	0.1111
37	0.1559	0.1055
38	0.1600	0.1000
39	0.1633	0.0924
40	0.1628	0.0825
41	0.1605	0.0738
42	0.1564	0.0648
43	0.1499	0.0560
44	0.1408	0.0472
45	0.1299	0.0402
46	0.1181	0.0355
47	0.1073	0.0335
48	0.0961	0.0346
49	0.0861	0.0373
50	0.0773	0.0388
51	0.0690	0.0414
52	0.0605	0.0460
53	0.0513	0.0493
54	0.0432	0.0492
55	0.0365	0.0442
56	0.0340	0.0363
57	0.0347	0.0256
58	0.0379	0.0117
59	0.0431	-0.0042
60	0.0492	-0.0238

PANEL F - MOODY´s SPREAD

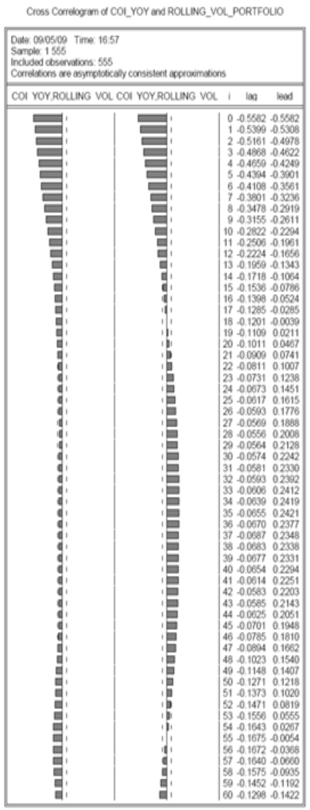


i	lag	lead
0	-0.4559	-0.4559
1	-0.4323	-0.4350
2	-0.4012	-0.4128
3	-0.3752	-0.3864
4	-0.3616	-0.3572
5	-0.3443	-0.3312
6	-0.3215	-0.3054
7	-0.2999	-0.2788
8	-0.2796	-0.2522
9	-0.2579	-0.2244
10	-0.2354	-0.1968
11	-0.2158	-0.1682
12	-0.1978	-0.1440
13	-0.1797	-0.1212
14	-0.1680	-0.0967
15	-0.1605	-0.0780
16	-0.1551	-0.0615
17	-0.1511	-0.0481
18	-0.1478	-0.0357
19	-0.1444	-0.0245
20	-0.1385	-0.0132
21	-0.1321	-0.0029
22	-0.1269	0.0081
23	-0.1210	0.0163
24	-0.1165	0.0216
25	-0.1116	0.0253
26	-0.1033	0.0242
27	-0.0935	0.0227
28	-0.0815	0.0232
29	-0.0686	0.0265
30	-0.0545	0.0289
31	-0.0383	0.0321
32	-0.0230	0.0355
33	-0.0079	0.0353
34	0.0074	0.0380
35	0.0227	0.0413
36	0.0389	0.0449
37	0.0549	0.0508
38	0.0700	0.0598
39	0.0843	0.0682
40	0.0969	0.0746
41	0.1065	0.0802
42	0.1130	0.0853
43	0.1175	0.0881
44	0.1171	0.0883
45	0.1135	0.0869
46	0.1094	0.0833
47	0.1031	0.0782
48	0.0933	0.0709
49	0.0822	0.0618
50	0.0698	0.0474
51	0.0568	0.0282
52	0.0432	0.0070
53	0.0287	-0.0192
54	0.0148	-0.0486
55	0.0027	-0.0798
56	-0.0080	-0.1123
57	-0.0168	-0.1447
58	-0.0254	-0.1762
59	-0.0333	-0.2049
60	-0.0399	-0.2313

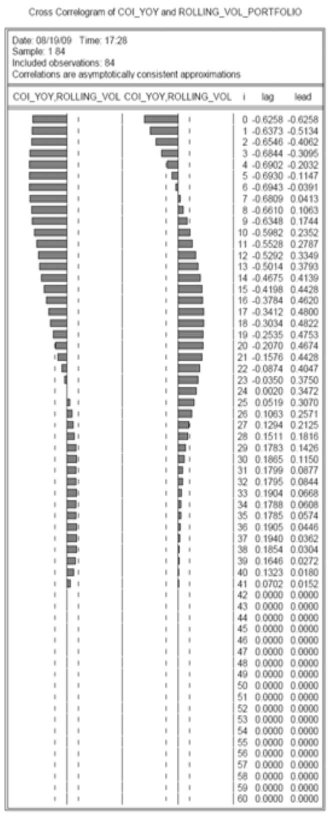
APPENDIX 4

CMP VOLATILITY AND COI YoY CROSS-CORRELATIONS

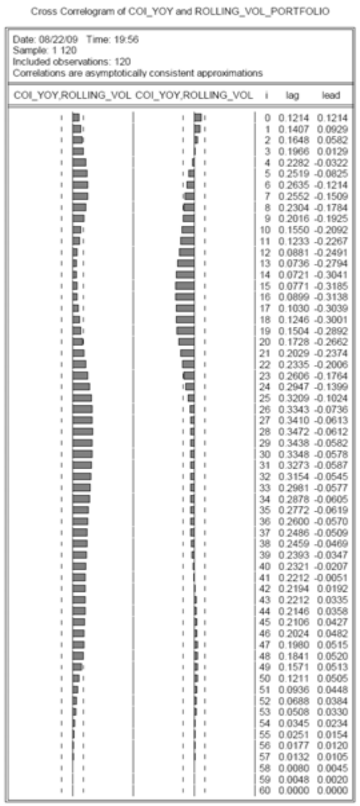
PANEL A - 1963 - 2009



PANEL B - 1963 - 1969



PANEL C - 1990 - 1999



APPENDIX 5

COI YoY - DESCRIPTIVE STATISTICS

COINCIDENT INDICATOR: YEAR-OVER-YEAR GROWTH RATE					
TIME PERIODS	AVERAGE	MEDIAN	MAXIMUM	MINIMUM	Nº of RECESSIONS
1963 - 1969	4.4%	4.2%	7.0%	1.9%	1
1970 - 1979	2.8%	3.9%	7.2%	-4.9%	2
1980 - 1989	2.2%	2.4%	7.1%	-3.1%	2
1990 - 1999	2.5%	3.0%	4.9%	-2.0%	1
2000 - 2009	1.0%	1.5%	4.0%	-5.2%	2

Note: This table reports statistical analysis for the year-over-year log growth rate of the Conference Board Coincident Indicator (COI). The time periods are the out-of-sample time frames considered in the regression models between the Coincident Indicator and the Capital Markets Portfolio Proxy (CMP). Recessions are officially defined by the National Bureau of Economic Research (NBER). Nº of recessions considers sub-periods of NBER recessions occurring in the time period. Sources: Bloomberg, NBER.

APPENDIX 6

CMP VOLATILITY - DESCRIPTIVE STATISTICS

CAPITAL MARKETS VOLATILITY PROXY: HISTORICAL VOLATILITY ANALYSIS						
TIME PERIODS	AVERAGE	MEDIAN	QUARTILE	MAXIMUM	MINIMUM	DISPERSION
1963 - 1969	5.6%	5.9%	1	9.5%	2.1%	7.4%
1970 - 1979	8.5%	8.0%	2	14.4%	3.5%	11.0%
1980 - 1989	12.6%	12.1%	4	20.1%	7.3%	12.8%
1990 - 1999	8.6%	8.7%	3	15.2%	4.5%	10.6%
2000 - 2009	9.1%	8.6%	3	17.7%	4.1%	13.6%

Note: This table reports statistical analysis for the monthly log returns historical volatility of the Capital Markets Portfolio proxy (CMP). The time periods are the out-of-sample time frames considered in the regression models between the Coincident Indicator and the Capital Markets Portfolio Proxy (CMP). Quartile columm is quartile where the median observation of each time period lies in comparison to the full-sample analysis. Dispersion is the difference between maximum and minimum historical volatilities for each time period. Source: Bloomberg.

APPENDIX 7

ASSET CLASSES - DESCRIPTIVE STATISTICS

3-MONTH T-BILL YIELD: HISTORICAL VOLATILITY ANALYSIS

TIME PERIODS	AVERAGE	MEDIAN	QUARTILE	MAXIMUM	MINIMUM	DISPERSION
1963 - 1969	0.6%	0.4%	1	1.2%	0.2%	1.0%
1970 - 1979	1.7%	1.5%	3	4.3%	0.6%	3.6%
1980 - 1989	2.5%	1.7%	4	6.2%	0.5%	5.7%
1990 - 1999	0.6%	0.6%	2	1.0%	0.3%	0.7%
2000 - 2009	0.7%	0.5%	1	1.8%	0.2%	1.6%

10YR TREASURY YIELD: HISTORICAL VOLATILITY ANALYSIS

TIME PERIODS	AVERAGE	MEDIAN	QUARTILE	MAXIMUM	MINIMUM	DISPERSION
1963 - 1969	0.4%	0.5%	1	1.2%	0.1%	1.1%
1970 - 1979	0.9%	0.9%	2	1.7%	0.4%	1.3%
1980 - 1989	1.8%	1.7%	4	3.2%	0.9%	2.3%
1990 - 1999	0.9%	0.9%	2	1.2%	0.5%	0.7%
2000 - 2009	0.9%	0.8%	2	1.6%	0.5%	1.1%

AVERAGE MOODY´s YIELD SPREAD: HISTORICAL VOLATILITY ANALYSIS

TIME PERIODS	AVERAGE	MEDIAN	QUARTILE	MAXIMUM	MINIMUM	DISPERSION
1963 - 1969	0.5%	0.5%	1	1.2%	0.1%	1.1%
1970 - 1979	1.0%	0.9%	3	1.8%	0.4%	1.4%
1980 - 1989	1.5%	1.5%	4	2.5%	0.6%	1.8%
1990 - 1999	0.7%	0.7%	2	1.1%	0.4%	0.6%
2000 - 2009	0.8%	0.7%	2	1.9%	0.3%	1.5%

S&P 500: HISTORICAL VOLATILITY ANALYSIS

TIME PERIODS	AVERAGE	MEDIAN	QUARTILE	MAXIMUM	MINIMUM	DISPERSION
1963 - 1969	11.0%	11.6%	2	20.8%	4.4%	16.4%
1970 - 1979	15.0%	14.4%	3	29.6%	6.1%	23.5%
1980 - 1989	15.8%	14.1%	3	32.5%	7.5%	25.0%
1990 - 1999	12.6%	13.2%	2	23.0%	5.0%	17.9%
2000 - 2009	13.3%	13.9%	3	27.1%	5.5%	21.6%

Note: These tables report statistical analysis for the monthly absolute differences historical volatility of 3-month yields, 10yr yields and average Moody´s spreads levels and for the monthly log returns historical volatility of S&P 500. The time periods are the out-of-sample time frames considered in the regression models between the Coincident Indicator and the different asset classes. Quartile columm is quartile where the median observation of each time period lies in comparison to the full-sample analysis. Dispersion is the difference between maximum and minimum historical volatilities for each time period. Source: Bloomberg.

APPENDIX 8

CAPITAL MARKETS PORTFOLIO PROXY HISTORICAL VOLATILITY (MAY/2006 - MAR/2009)

REGRESSION WITH CAPITAL MARKETS PORTFOLIO VOLATILITY (MAY/2006 - MAR/2009)							
	CMP VOLATILITY: LEADS-LAGS						
REGRESSION STATISTICS	-3	-2	-1	COINCIDENT	+1	+2	+3
ESTIMATED COEFFICIENT	-0.67	-0.62	-0.44	-0.37	-0.36	-0.33	-0.31
T-STATISTICS	-14.92	-21.91	-6.10	-6.53	-7.75	-9.09	-10.39
P-VALUE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Nº OF OBSERVATIONS	34	35	36	37	36	35	34
R-SQUARED	0.91	0.93	0.84	0.84	0.88	0.90	0.91

Note: This table reports output statistics from OLS regressions between the Conference Board Coincident Indicator log returns (COI YoY) (dependent variable) and US Capital Markets Portfolio (CMP) log returns volatility and leads and lags of COI YoY. CMP volatility consists of 12-month rolling annualized historical volatility of US Capital Markets Portfolio log returns. Annualised historical volatility follows mean-variance calculations of a portfolio with more than one security. Newey-West standard errors are computed. Data frequency is on a monthly basis. Conference Board Coincident Indicator data is available since 31/Jan/1959. US Capital Markets Portfolio data is available since January 1963. US Capital Markets Portfolio is composed by: Equity Market Capitalisation (S&P500), Government Debt Outstandings, Corporate and Financial Debt Outstandings and Total Debt Outstandings up to 1 year maturity. Monthly Asset Classes weightings in the US Capital Markets Portfolio are averages of the last 12-month observations. Equity Market Capitalisation available since Jan/1962. Debt Outstandings available since Dec/1990. Asset Classes Weightings are constant between Jan/1963 and Dec/1990. Sources: Bloomberg, S&P, BIS.

APPENDIX 9

RECESSIONS, DOWNTRENDS AND UPTREND PERIODS

PANEL A - NBER RECESSIONS

NBER - BUSINESS CYCLE REFERENCE DATES		
PEAK DATE	THROUGH DATE	PEAK TO THROUGH
DECEMBER 1969	NOVEMBER 1970	11
NOVEMBER 1973	MARCH 1975	16
JANUARY 1980	JULY 1980	6
JULY 1981	NOVEMBER 1982	16
JULY 1990	MARCH 1991	8
MARCH 2001	NOVEMBER 2001	8
DECEMBER 2007	...	...

Note: This table reports all the official recessions determined by the National Bureau of Economic Research (NBER), occurred in the full-sample analysis (January/1963 - March/2009). Peak to through is the contraction period measured in months. The determination that the last expansion ended in December 2007 is the most recent decision of the business cycle dating committee of NBER. Source:NBER

PANEL B - COI YoY DOWNTRENDS

COI YoY DOWNTRENDS		
PEAK DATE	THROUGH DATE	PEAK TO THROUGH
OCTOBER 1969	NOVEMBER 1970	13
NOVEMBER 1972	MAY 1975	30
JANUARY 1979	JULY 1980	18
JULY 1981	AUGUST 1982	13
MAY 1984	MARCH 1986	22
JANUARY 1988	MARCH 1991	38
APRIL 2000	DECEMBER 2001	20
AUGUST 2006	MARCH 2009	31

Note: This table reports all the periods where there was a visible and significant downtrend in the year-over-year rate of change of the Conference Board Coincident Indicator (COI YoY), occurred in the full-sample analysis (January/1963 - March/2009). Peak to through is the downtrend period measured in months. Source:Bloomberg.
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PANEL C - COI YoY UPTRENDS

COI YoY UPTRENDS		
THROUGH DATE	PEAK DATE	THROUGH TO PEAK
NOVEMBER 1970	NOVEMBER 1972	24
MAY 1975	APRIL 1976	11
OCTOBER 1982	MARCH 1984	17
MARCH 1991	JANUARY 1995	47
DECEMBER 2001	DECEMBER 2004	36

Note: This table reports all the periods where there was a visible and significant uptrend in the year-over-year rate of change of the Conference Board Coincident Indicator (COI YoY), occurred in the full-sample analysis (January/1963 - March/2009). Through to peak is the uptrend period measured in months. Source:Bloomberg.
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