Quantitative Research Methods-DAL 01

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Prof.: P. Scholfield

Student: John N. Exarhos ID# 2990

“Financial Instruments

(Bonds & Stocks)

their Relationship”

Are there possible correlations in these instruments based on market movements & expectations?

If correlation exists, is it affected by external changes & interventions in the market?

Executive Summary

Throughout much of the 20th century, the correlation between equity prices and government bonds have fluctuated but again, they have tended to be negative in their overall correlation. Stock & bond correlations have been largely positive since the late 1990's and rose strongly even more towards positive correlation during the global financial crisis and since then, have remained at a high level of correlation for a long period. However, during the current & recent period of positive correlation in bonds and stocks one is able to notice that it is due in part to the reflection of the pronounced and persistent effect of the financial crisis and on the economic outlook in the market, though it may also owe it's positive correlation in part to an increase in the importance of uncertainty about real economic activity. Changes such as Global Monetary Policy look to have exerted an opposing force on the correlation at times, driving this positive correlation to lower or even negative correlations due to intervention.

Imperfect correlation of asset classes such as stocks and bonds are based on a fundamental assumption used in financial theory and it is the basis for constructing diversified investment portfolios **(Markowitz 1952; Sharpe 1964)**. However, correlations of returns on various risky &/or risk-free assets such as oil, real estate, alternative investments, hedge funds or the currency market (f/x), do change over time and have at times switched signs going from negative to positive correlations.

Introduction

The recent Global Financial crisis during the period of (2007-2018) but still in an unwinding process, is known to most of us as the most recent “Black Swan” (**Taleb Nassim, “The Impact of the Highly Improbable”, 2007**) and has also been correlated too often to the crisis of the 1930’s, also known as a Black Swan but more specific or commonly known as the “The Great Crash” or “The Great Depression”. Both Black Swans have shown positive correlations between stocks and bonds instead of negative and have been commonly ascribed to as the emergence of a “‘risk-on-risk-off” paradigm, (**Tariq Haque, 2010**). Nevertheless, it is notable that the stock-bond yield correlation had already been positive for most of the decade before the global financial crisis.

The correlation between stocks and bonds is one of the most important relationships in financial theory and portfolio management as well as for many common households throughout the world, which try to strike and accomplish a fine-tuning or balance between the exposure or avoidance of risk in their daily investments; which risk is depicted in a nutshell as a positive correlation in these two most common financial instruments used by all households in order to achieve either their retirement goals, college funding, health care expenses, charity goals, real estate funding and many-many more personal or collective goals known commonly as personal welfare & well-being goals.

Discussion

This difficulty in estimating reliably the correlation between stocks and bonds has changed drastically with recent macro-economic conditions.[1] From 1927 to 2013, the correlation between the Standard & Poor's Index (S&P 500) the best index globally to track stocks vs. Government Bonds, which are represented by the commonly known Treasury Bills, has changed signs form positive to negative more than 28 times in this particular time frame.

Fundamental drivers of Stock Prices and Bond Yields at a more simple level, are driven by variables which reflect expectations for, and uncertainty about, **growth and inflation**. In particular, changes in investors' expectations for growth and inflation determine their forecast for dividends expected to be collected by stocks and interest rates on the other hand reflect a stronger economic growth in the market driving a higher inflation therefore, an increase in bond yileds. An increase in uncertainty about growth raises the equity risk whereas increased inflation and uncertainty raises both variables.

Whether these market shocks cause equity prices and bonds to move in the same, or the opposite direction is theoretically ambiguous. While positive growth or inflation shocks raise bond returns, they have an uncertain impact on stock prices:

1. **growth shocks** in the market **raise** the **correlation**
2. **inflation shocks** may **lower** the **correlation**

3. an increase in **uncertainty** about the **outlook for growth** will **raise** the **correlation**
4. an increase in **uncertainty** about the **outlook for inflation** will **reduce** the **correlation**
5. **positive employment data** and **surprises** tend to increase earnings growth expectations therefore, a **rise in correlation**

As a result, positive employment data surprises tend to increase both stock prices and bond returns The stock-bond correlation may be more than very challenging to be estimated and several factors influence this stock-bond correlation and in particular four (4) key macroeconomic factors:

1. **Real Interest Rates (r)**
2. **Inflation (i)**
3. **Unemployment (u)**
4. **Gross Domestic Product (GDP-(C+I+G+X-I)**

Stocks and bonds have the **same** sensitivity to **inflation**, while their sensitivity to **growth** and **unemployment** have **opposite** signs. Depending on which factors dominate, the correlation can be either positive or negative. Short run and long run dynamics, must be incorporated in order to enable accurate correlations for various time horizons. Short and long run correlations may differ for a variety of reasons:

1. in the short run, stocks and bonds tend to respond in opposite directions to fluctuations in investor risk appetite
2. during **"flight-to-safety"** situations in the market observations of such type were made and they had a negative correlation

3. in the long run, short run trends in growth, inflation and interest rates may have similar effects on stock and bond returns, creating a positive correlation.

The negative **"beta"** (a measure of volatility, or systematic risk of a portfolio or a security) between stocks and inflation may be less similar over longer horizons as stock dividends gradually catch up to inflation.

Valuation levels may play an important role in bonds and stocks since, if the Central Bank has over-valued both classes, joint mean reversion in their valuations should generate a positive, or less negative correlation, even though business cycles and other related factors generate usually a negative correlation.

Shifts in monetary policy regimes can result in the stock-bond yield correlation declining, given that higher interest rates raise bond returns but reduce future earnings. This was likely to have been one driver of the strongly negative correlations in the early 1980's, a period in which volatility in interest rates was especially high due in part to efforts by the Federal Reserve to lower the level of inflation. More recently, there is evidence that the Federal Reserve's asset purchase program, "**quantitative easing"** which depressed the level of Treasury yields (**Bernanke 2013; Krishnamurthy & Vissing-Jorgensen 2013)**, while it was likely to have raised equity prices. As a result, stock-bond yield correlations **fell towards zero** briefly in 2009 & 2011.

The current environment of the stock-bond correlation showed a short run correlation which was very negative. One question which must be answered is whether higher interest rates or rising inflation in the future may make this correlation less negative, or even positive.

Studying the effect of macroeconomic factors on the stock-bond correlation throughout history it has been noticed that the concept of duration (a risk measure used for bonds) provides an intuitive way to think about the stock-

bond correlation. **Shiller** and **Beltratti (1993)** explained that the return correlation between stocks and bonds should be positive, because both of them represent discounted cash flow streams and rising rates should lead to declining valuations for both asset classes, while declining rates should lift all valuations.

Shiller and Beltratti (1993) however emphasise that, “the dividend stream that is discounted for stocks is radically different from the principal and coupon stream accruing to bond holders.” Over time, changes in how investors value future risky cash flows drive a significant portion of equity volatility. **Leibowitz, Sorensen, Arnott and Hanson (1989)** explain how simply looking at equity duration from the perspective of discounted cash flow models lead to results that are divorced from empirical reality, due to the complicated links between the discount rate, the nominal interest rate, inflation and the growth rate. **(Leibowitz, 1993).**

Similarly, **Li (2002)** documents large variations in the correlation between stocks and bonds over time. She shows that common exposure to macroeconomic factors which drives this correlation and she identifies uncertainty about expected inflation as the key factor, followed to a lesser extent by the real interest rate.

Andersson, Krylova, and Vahamaa (2004) identify inflation as a key factor driving the equity-bond correlation. The authors find that prices tend to move in the same direction when inflation expectations are high. In addition, they and others such as **Gulko (2002)** identify a “flight-to-safety” effect, according to which the correlation becomes significantly negative during equity market drawdowns. In general, they show that when implied volatility is high, stock and bond returns become more negatively correlated. In the same frame of thought, **Baele, Bekaert, and Inghelbrecht (2009)** test for a wide range of factors and find that liquidity is important for the stock-bond correlation, and suggest this factor may be correlated with the flight-to-safety effect.

Results

Previous studies may disagree on the key factors that drive the stock-bond correlation simply because they rely on different time periods in history. In **Figure 1,** the history of the correlation between the S&P 500.

The correlation estimates vary in the range and standard deviation. The correlation was lower in seven years, and more positive in 14 years, which indicates a greater tendency for the correlation to “move” up versus going down. It is also notable that the positive estimates of this correlation in the 1970’s and 1980’s showed negative values since the mid-1990’s. This is not just a current phenomenon. Negative correlations were observed during the 1950’s as well as during the Great Depression and in general, during periods when the **business cycle dominated all asset returns.**

FIGURE 1: HISTORY OF THE STOCK-BOND CORRELATION (YEARLY ESTIMATES)

Source: Bloomberg: (June 1927- June 2013)

The data in **Figure 2** suggest that a regime shift from positive to negative correlation occurred around 1997. The data sample starts in 1951 to focus on the period following the Treasury-Fed given authority and was recognised as independent of the Federal Reserve to conduct monetary policy.

FIGURE 2: REGRESSION RESULTS

	α	β_1 **(Inflation)**	β_2 **(Real rates)**	β_3 **(1997)**	p^2
Coefficient	-0,15	0,07	0,07	-0,28	0,39
Std. Error	0,10	0,02	0,02	0,11	

Source:

Bloomberg: (June 1951 - June 2013)

The analysis confirms that both the real rate and inflation components are significant. **Both higher inflation and higher real rates have been associated with elevated stock-bond correlations, and these effects are statistically and economically significant.**

These positive coefficients are likely due to the fact that the return sensitivities of both asset classes to inflation and real rates have the same sign. Therefore, if these factors dominate, the correlation should increase.

Correlations used in this analysis are focused on short run business cycle fluctuations, which tend to generate low or negative stock-bond correlations when rates and inflation volatilities are suppressed as evidenced by the

intercept (α) of −0.15. There is also strong evidence of a structural downward shift in the correlation post 1997.

One of the growing trends in asset and risk allocations is to adopt a forward looking view driven by macroeconomics, rather than a backward-driven view generated by historical statistics. This is particularly important in the context of a likely rise in interest rates, something a backward-looking view would not incorporate, and the impact that would have on the stock-bond correlation.

While many factors influence the stock-bond correlation, analysis reveals the importance of four key macroeconomic factors: real interest rates, inflation, unemployment and growth. Stocks and bonds have the same sign sensitivity to the real (inflation-adjusted) policy rate and to inflation, while their sensitivity to growth and unemployment have opposite signs. So depending on which factors dominate, the correlation can be positive or negative. If growth concerns, such as unemployment or GDP drive volatility, then the correlation can be expected to be more negative. If surprises in interest rates and inflation dominate volatility then you can get a positive stock-bond correlation.

At the same time the stock-bond correlation could be changing, an allocation to alternative financial instruments (private equity, hedge funds, real estate, commodities, F/X etc.) may not be the solution for a portfolio diversification and risk aversion. These concepts are not new to the investment world but **they are worth noting** though, since the **momentum with which they are trending is making them mainstream.**

Rather than relying on a backward-driven views generated by historical statistics, investors should formulate a forward-looking view driven by macroeconomics. Investors must recognise the dynamic nature of markets and make asset allocation decisions on a **cyclical** and **secular basis** rather than a **calendar-year basis.**

Figure 3, reports the parameter estimates alongside t-statistics in both levels of regression along with an error correction model.[2]

The coefficients on the business cycle variables (GDP and unemployment) have opposite signs for bond and equity earnings yields, both in terms of levels and changes. If the regression was based on changes such as an 1% increase in the GDP the gap would increase the yield on the 10-year Treasury bond by 45 basis points, while it would decrease earnings yields by 42 basis points (stock prices would increase). When those variables dominate the macroeconomic environment, expectation of a negative stock-bond correlation may be expected. Historically speaking, stocks have not been a good hedge for inflation.[3] When inflation dominates over the influence of the other factors, stock-bond return correlation are expected to be positive. Bond and equity yields have opposite sensitivities to the Fed funds policy gap, based on the levels of regression. This result is likely due to the Federal Reserve's policy to keep rates low when unemployment is high and vice versa.

FIGURE 3: ERROR CORRECTION MODEL

Level regression	Nominal 10 year yield			Earnings yield		
Variable	**Coef.**	**Value**	**T-stat**	**Coef.**	**Value**	**T-stat**
Constant	α_{β}	0,05	67,22	α_{ε}	0,04	86,67
GDP growth	β_{1}	0,41	2,79	θ_{1}	-0,47	-5,05
Unemployment	β_{2}	-0,84	-7,89	θ_{2}	0,77	11,33
Inflation	β_{3}	1,72	14,90	θ_{3}	1,07	14,37
Rates (Policy gap)	β_{4}	0,50	6,18	θ_{4}	-0,26	-4,90
R-square		84%			82%	

Changes	Nominal 10 year yield			Earnings yield		
Variable	**Coef.**	**Value**	**T-stat**	**Coef.**	**Value**	**T-stat**
Δ GDP growth	γ_{1}	0,45	2,99	φ_{1}	-0,42	-4,28
Δ Unemployment	γ_{2}	-0,45	-1,90	φ_{2}	0,42	2,61
Δ Inflation	γ_{2}	0,90	3,01	φ_{3}	0,30	1,38
Δ Rates (Policy gap)	γ_{4}	0,39	3,27	φ_{4}	0,02	0,27
ECM	ϱ_{b}	-0,20	-3,06	ϱ_{e}	-0,31	-4,02
R-square		23%			29%	

Source:
Bloomberg: Survey of Professional Forecasters & Haver. (Q1 1988 – Q2 2013)

The Central Bank policy has clearly pushed rates levels below their modelled values and statistics capture a proportion of the dynamics for both stock and bond Figures 4 & 5. **Stock-bond correlation is a cornerstone of strategic asset allocation,** and investors should understand it's sensitivity to macro-economic factors. Applications that primarily rely on estimates of correlation, such as **mean-variance optimisations, can be misleading** if the investors do not take into account current conditions and **possible macroeconomic regime shifts.**

Although many other factors may matter such as growth, unemployment, inflation and real rates which are all key drivers of macroeconomic risk, while are also responsible for a significant portion of the dynamics in the correlation found in stocks and bonds.

In the short run, the correlation is to remain negative as long as business cycle variables dominate the effects of rates and inflation. In the long run, bonds may still diversify stocks, but the correlation may be higher and even positive due to the influence of inflation and the smoothing of business cycle and risk aversion effects.

FIGURE 4: ACTUAL vs. 10-YEAR TREASURY

FIGURE 5: ACTUAL vs. S&P 500 EARNINGS

Source: Bloomberg :Data as of (Q1 1988 – Q2 2013)

Conclusion

The stock-bond yield correlation has been positive for an extended period over the past 15 years, in contrast to the negative correlation observed throughout much of the 20th century. An important factor underlying the recent, relatively long period of positive correlations has been the considerable and persistent uncertainty created by the global financial crisis, which saw correlations rise in a continuation of the pattern observed during other recessionary periods over the past century. The relatively long period of positive correlation is consistent with an increase in the importance of uncertainty about future economic activity in driving investor asset allocation decisions. Shifts in monetary policy regimes have been associated with reduced stock-bond yield correlations, although it is difficult to distinguish between the impact of recent unconventional monetary policies and the economic developments that have supported such policies.

Over the last 25 years, many investors have been able to ignore inflation risk and have taken for granted the very negative correlation between stocks and bonds. In the next decade though, particularly in light of aggressive and

expansive central bank monetary policy, as we see it taking place today through 2018 and for the 1st time after nine (9) years we expect the Fed to impose a change another 2-3 times within 2018, the importance of the **inflation risk factor may indeed resurface**. I**f so, many of the correlation dynamics that investors have become accustomed to may be less relevant.**

In retrospect, my paper assumes linear relationship and the **flight-to-safety** effect during extremely negative growth shocks which may overwhelm any

other effect and produce a negative correlation between stocks and bonds, despite inflation shocks.

In retrospect, my personal view is not to undermine the importance of assessing potential macroeconomic regime shifts when making asset allocation decisions but rather one should augment his/her judgments by experience and evaluation of risk, taking in consideration specific variables at any given moment in time going forward, since we have experienced "**Black Swans**" in the economy more than twice (1929 & 2008).

Asset classes don't offer true diversification and investors should build their thoughts and investment actions around risk factors, rather than asset classes. There is plenty of factual evidence to prove that these market patterns occur across a number of different economic backdrops and most banks and financial institutions predict shifts between these, and simultaneously will continue to provide and bring-up problems for investment correlations therefore, asset allocation. **It has been proven by monetary policy, black swans and by the paradigm of "flight to quality" that, risk factors are far truer diversifiers, than classical correlation modifiers, when one wishes typically to spread assets (money) onto various asset classes, such as bonds & stocks.**

Equity risk which is indirectly exposed to factors out of the usual **macroeconomic values is like a virus,** it remains embedded & nocturnal, until the body weakens. It tends to make it's appearance during extreme. market movements.

On average, correlations across risk factors are lower than correlations across asset classes (stocks & bonds), and risk factor correlations tend to be more robust to regime shifts than asset class correlations. Therefore, a risk factor approach to investment decision making provides a powerful platform for investors to express cyclical and secular macroeconomic views and adapt to regime shifts

Methodology

My final statements are based on the conclusion of the analysis of comparative **market data between 1988 & 2013,** found on the **Bloomberg Station** (a very expensive and highly professional tracking tool and **Extensive Bibliography** by **Nobel Prize** and **other Economic & Finance Scholars.**

By focusing on those periods, market prices changed in response to significant events as well as those periods when there were no significant market events affecting price changes.

Turbulent market data, includes such market shaking events such as the:

- Asian Financial Crisis
- The Russian Debt Default
- The LTCM collapse of the late 1990's
- The DotCom Bust
- The 9/11 Terrorist Attack
- The 2008 Credit Crisis (collateral debt & mortgage crisis)

Risk factors are defined as:

1. Equity Size
2. Value & Momentum
3. Bond Duration
4. Emerging Markets interest rates
5. Mortgage interest rates
6. Corporate interest rates
7. Real Estate & Commodity prices

Market turbulence may be defined by the Mahalanobis Distance based on both volatility and other common elements, (**P.C. Mahalanobis, 1936**) standard deviation and correlations for both asset classes (bonds & equity) and risk factors for the turbulent and quiet market periods. In the quiet periods there was a 30% correlation between asset classes while just a 2% correlation between risk factors. But during turbulent times, asset class correlation grew to 50% while risk factor correlation actually fell, to 1.6%.

Appendix

To simulate the behaviour of key macroeconomic variables, projected Federal Open Market Committee (FOMC) data are used as a mean outcome for each variable. These forecasts are provided on an annual basis.

The annual projections as of June 2013 are shown in Figure A1. The gaps are estimated as differences from the sample average (Q1 1988 – Q2 2013). The historical statistics for the macroeconomic variables are shown at the bottom of Figure A1.

FIGURE A1: FOMC PROJECTIONS AND HISTORICAL DATA FOR MACROECONOMIC VARIABLES

	Real GDP growth	Unemployment	Inflation rate	Real policy rate	Rates implied by Taylor rule
FOMC Projections					
2013	2,45%	7,25%	1,00%	0,25%	-0,74%
2014	3,25%	6,65%	1,70%	0,45%	1,51%
2015	3,35%	6,00%	1,80%	1,35%	2,96%
Gaps					

2013	-0,22%	1,20%	-1,46%	0,99%	-
2014	0,58%	0,60%	-0,76%	-1,06%	-
2015	0,68%	-0,05%	-0,66%	-1,61%	-
Historical Data (Q1 1998 to Q2 2013)					
Mean Levels	2,67%	6,05%	2,46%	1,39%	-
Min	0,79%	3,90%	1,30%	-1,73%	-
Max	4,01%	9,90%	4,66%	5,21%	-
Std. deviation	0,61%	1,58%	0,81%	2,04%	-
Mean changes	0,01%	-0,06%	-0,02%	-0,04%	-
Min	-0,93%	-2,00%	-0,66%	-1,94%	-
Max	1,10%	1,00%	0,37%	0,74%	-
Std. deviation	0,33%	0,52%	0,18%	0,46%	-

Sources: FOMC (data as of June 2013), Haver, Bloomberg: (Q1 1988 – Q2 2013)

FIGURE A2: PARAMETERS OF STOCHASTIC PROCESSES / MACROECONOMIC VARIABLES

	Correlations and volatilities of ε's				Parameters		
Correlation	**GDP**	**Unemployment**	**Inflation**	**Rates**	**Volatility**	**α**	**β**
GDP	100 %				0,6%	25%	-18%
Unemployment	-25%	100%			0,4%	71%	-3%
Inflation	-1%	-22%	100%		0,4%	6%	-4%
Rates	-3%	62%	-40%	100%	1,0%	40%	-5%

Source : Bloomberg: (Q1 1988 – Q2 2013)

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Footnotes

1.

See, for example: Wainscott (1990), Li (2002), Gulko (2002), Andersson, Krylova and Vahamaa (2004), Baele, Bekaert and Inghelbrecht (2009).

2.

Due to the borderline non-stationary nature of most of the macro variables involved, the t-statistics and R-squares in the levels regression should not be interpreted as a very reliable estimate of “significance.”

3.

Whether stocks are negatively correlated to inflation, investors must be confident the recurrent factors that give rise to the negative correlation between inflation and stocks are prevalent in the current environment. **Empirically it appears the correlation is negative for a wide range of time periods, horizons and countries.**

See, for example, Fama and Schwert (1977), Fuller and Petry (1981), Geske and Roll (1983), Stulz (1986), Wilson and Jones (1987), Hughes (1992), Asikoglu and Ercan (1992), Marshall (1992), Weigel (1994), Erb, Harvey, and Viskanta (1995), Watkins and Hartzell (1998), Bhardwaj, Hamilton, and Ameriks (2011), Feinman (2005) and Amenc, Martellini, and Ziemann (2009).