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U.S. stock markets and the role of real interest rates

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ABSTRACT

Using weekly data from January 3, 2003 to March 27, 2015, we examine the responses of U.S. stock returns (S&P 500, DJIA, and NASDAQ) to monetary policy, controlling for WTI oil prices and the value of the U.S. dollar (USD) against major currencies. Based on differences between the federal funds rate and inflation expectations, U.S. real interest rates have become continuously negative since January 28, 2009. Vector auto-regressions (VARs) suggest stronger linkages more recently and vine copula models identify the structure of dependence across these markets, which can help investors optimize portfolio diversification.

1. Introduction

The severity of the most recent U.S. recession of 2008–2009 has led to a combination of expansionary fiscal and monetary policies by government and central bank alike. On monetary policy, in particular, in addition to the very low federal funds rate the U.S. Federal Reserve has put forward a monthly USD 85 billion bond-buying program aimed at keeping long-term interest rates low.[1] Following the theoretical model by Chen, Roll, and Ross (1986), current stock prices reflect expected cash flows (earnings) discounted by the appropriate interest rates. Very low interest rates make the discounted cash flows high, thus justifying the increases in current stock prices.

U.S. stock markets have indeed been moving upwards (with very high rates of return) since bottoming out in March 2009. The U.S. FOMC September 2013 decision illustrates well the typical market reaction right after the announcement: "On Wednesday, the Federal Reserve gave the markets uncertainty and confusion about plans to wind down its bond-buying program, and markets loved it, sending U.S. stock indexes to records. The Dow Jones Industrial Average rose 147.21 points, or 0.9%, to 15,676.94, a closing high. Bond prices notched their strongest gain since November 2011. Commodity prices jumped, and foreign stocks benefited even more than U.S. shares. The celebration was for the short term, based on the Fed's decision to surprise investors with the news it wouldn't begin reducing its bond-buying program after all." (The WSJ, September 19, 2013). For the whole of 2013, stocks have returned 27% (DJIA) and 30% (S&P 500), making the year one of the best ever for equity markets.

This paper estimates U.S. stock market responses to monetary policy, allowing for oil prices and exchange rates conveying important information from other financial markets around the world. While recent research by Laopodis (2013) suggests varying U.S. stock market responses to the FED conduct of monetary policy, we allow in this paper for a combination of nominal interest rates and price pressures in goods markets as the driving forces, controlling for other financial markets. We pay particular attention to the extremely low levels of nominal interest rates in the U.S., which has made the real interest rate become negative. We identify two subsamples to test changes in the relationships among the series over time by picking up the date in which real interest rates have become negative (on January 29, 2009). According to Fig. 1, there is a period before the 2008–2009 when real interest rates dropped below zero. That was short-lived, however, recovering afterwards

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[1] One year into the recession, in early December of 2008, the effective Federal Funds rate was moved down to 0.12% on December 5, following levels of 0.52% on December 1 and 1.04% on October 15. From December 2008 onwards, the rate remained at the current very low levels within the 0.06–0.25% range. On October 15, 2013 it stayed at 0.10% using daily data from the U.S. Federal Reserve of St. Louis at http://www.research.stlouisfed.org/fred2/categories/118. In addition, Quantitative Easing programs were established in steps: QE1, QE2, and QE3.

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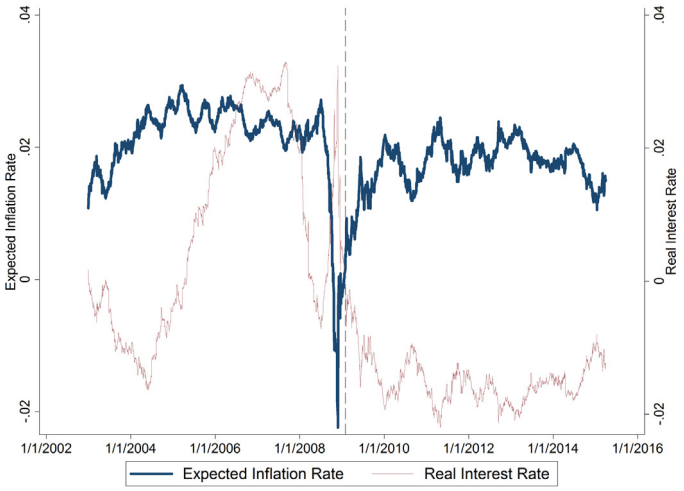

Fig. 1. Movements of the expected inflation and *ex-ante* real interest rates.

to the more normal positive rate, representing a greater than zero marginal product of capital. Following the intensity of the crisis, the real interest rate became negative and remains negative at the time of writing. Having the marginal product of capital become negative in the U.S. for more than six years has probably helped equity markets in the short-run. In addition, it may also have changed dramatically the nature of how stock prices respond to major financial markets.

It is important, however, to allow for cross-market financial linkages. The empirical literature on commodity and financial markets contains a variety of established results. Vector autoregressions (VAR) by Cologni and Manera (2008) suggest that policymakers adjust interest rates in response to oil price shocks. Theories based on the opportunity cost of oil extraction and storage suggest that falls in real interest rate results in lower production (and higher prices) and vice versa.[2] Akram (2009) finds that oil prices increase with negative movements in U.S. real interest rates. In his quarterly VAR model from 1990:1 to 2007:4 with OECD industrial production, the real interest rate, effective real exchange rate, and real price of oil, shocks to the real interest rate account for more than 20% of the forecast error variance in oil prices and real exchange rate fluctuations account for a little lower than 20%. Arora and Tanner (2013) revisit this conjecture for monthly frequency VAR from 1975:1 to 2012:5 and conclude that oil prices have become more responsive to long-term U.S. and international real interest rate after 2000. As for the link between oil and exchange rates in the long-run, Lizardo and Mollick (2010) find that oil prices significantly explain movements in the value of the U.S. dollar (USD) against major currencies from the mid-1970s to 2007:12 (with varying start dates), while Beckman and Czudaj (2013) find cointegration in monthly data from Jan 1974 to Nov 2011 between oil WTI prices and the real broad index (USD versus 26 currencies), as well as with the major index (USD versus 7 major currencies).

Since an expansion of domestic money depreciates the USD against other currencies, lower U.S. interest rates suggest (by the UIP condition) that the rate of depreciation of the USD must fall. It is thus important to control for exchange rate effects when verifying the links between real interest rates and oil prices and between real interest rates and stock prices. Of particular interest is the period when the FED started expanding its balance sheet to handle the financial crisis. There are, of course, many ways to identify changes in monetary policy. We will focus in this paper on a market-driven indicator based on when the U.S. real interest rate became negative for a substantial amount of time, which has been recently used by Huang, Mollick, and Nguyen (2015) on a study of disaggregated commodities (copper, cotton, gold and oil) and the value of the USD; yet without considering stock markets.

There are three main reasons for revisiting the attention to equity markets for the particular sample used in this paper. First, there is a vast literature developed by Campbell and Ammer (1993) and Thorbecke (1997) for U.S. data and extended to international stock markets by Campbell (1998), which focus on a time period of positive real interest rates for postwar economic data. Second, for the cyclical behavior of the Kydland–Prescott economy reported in Prescott (1986), the standard deviation of U.S. GNP is 1.79%, of hours is 1.23% and of real interest rate is only 0.22%, which makes it considerably less volatile than output. Since the real interest rate can be interpreted as the marginal product of capital, it is interesting to know if the present value discounted model of stock prices behaves differently under positive and negative (real) returns. Third, examining relatively symmetric subperiods of volatile versus always negative real interest rates in this sample (317 and 322 weekly observations, respectively) allows a finer comparison of monetary policy forces against foreign exchange and commodity prices.

Using weekly data from January 3, 2003 to March 27, 2015, we examine the responses of U.S. stock returns (S&P 500, Dow Jones, NASDAQ) to monetary policy, controlling for WTI oil price returns and the value of the U.S. dollar (USD) against major currencies. Correlation coefficients show very different co-movements between the two periods and VARs suggest stronger linkages in the more recent period. In particular, we find for stock markets that they respond – in the more recent period – negatively to both real interest rates (and to the value of the dollar) and positively to increases in oil price shocks. Also, the magnitudes of the responses are larger in the period of financial crisis and Quantitative Easing.

Vine copula models complement the above time series methods by looking at the dependence pattern among the four financial markets. One of the most remarkable features of copulas is that they capture the whole dependence structure between variables and not only the linear correlation between them. The vine copula methodology was proposed by Aas, Czado, Frigessi, and Bakken (2009), based on Joe (1996) and Bedford and Cooke (2001, 2002), and developed further by many articles in the recent literature. See, e.g., Dißmann, Brechmann, Czado, and Kurowicka (2013) and references therein, Min and Czado (2014), Beare and Seo (2015), Brechmann and Joe (2015), Schepsmeier (2015), Weiß and Scheffer (2015), etc. Vine copula has been widely applied in finance, see, e.g., Low, Alcock, Faff, and Brailsford (2013), Weiß and Supper (2013), Abbara (2014), Arreola Hernandez (2014), Brechmann, Czado, and Paterlini (2014), Markwat (2014), Allen, McAleer, and Singh (2014), Zhang (2014), Siburg, Stoimenov, and Weiß (2015), etc. For example, it can be applied in portfolio optimization in mainly two directions. Efficient diversification of investments based on the mean-variance analysis of Markowitz (1952) is widely used, however, its normality assumption does not usually fit the data in finance. Mendes, Mendes Semeraro, and Cmara Leal (2010) thus propose a robust vine copula mean-variance method, which is applied in Mendes and Marques (2012) and Arreola Hernandez (2014). In order to catch skewness and asymmetric dependence for asset allocation, Patton (2004) proposes a new method of portfolio optimization in the bivariate case using copulas, which can be easily extended to the multivariate

[2] Akram (2009) discusses the no-arbitrage condition in detail. There are at least three channels in which the real interest rates inversely affect commodity prices. First, low real interest rates increase the price of storable commodities by increasing the incentive for extraction tomorrow rather than today. When the today supply reduces, the price of the commodities will increase. Second, low real interest rates allow firms to store more commodities. When the demand for a commodity is increasing, its price will rise. Third, when the real interest rate is too low, investors tend to shift their investment from T-bill into commodities, causing increases in the demand for commodities, thus the price.