Journal of Financial Economics 125 (2017) 72–98

Contents lists available at ScienceDirect

Journal of Financial Economics

journal homepage: www.elsevier.com/locate/jfec

Explaining the negative returns to volatility claims: An equilibrium approach☆

Bjørn Eraker[a,*], Yue Wu[b]

[a] Wisconsin School of Business, Department of Finance, 975 University Avenue, Madison, WI 53706, USA
[b] Moody's Analytics, 405 Howard Street #300, San Francisco, CA 94105, USA

ARTICLE INFO

Article history:
Received 14 December 2015
Revised 5 May 2016
Accepted 1 June 2016
Available online 10 May 2017

JEL classification:
G12
G13
C22
C58

Keywords:
Variance risk premium
VIX futures
VIX ETN
Dynamic equilibrium
Jump-diffusion

ABSTRACT

We study the returns to investing in VIX futures, VIX Exchange Traded Notes (ETNs), and variance swaps. We document substantial negative return premia for these assets. For example, the constant maturity portfolio of 1-month VIX futures loses about 30% per year over our sample period (2006–2013). We investigate if these findings are consistent with dynamic equilibrium. We derive a model based on present value computation that endogenizes stock prices, the VIX index, and its associated derivative contracts. The model explains the negative return premia as well as several other stylized features of the VIX futures, ETNs, and variance swap data.

1. Introduction

In 2004, the Chicago Board Options Exchange (CBOE) Futures Exchange introduced cash settled futures contracts on the CBOE VIX volatility index. While initially sparsely traded, the VIX futures market has become very liquid in recent years. In addition to the futures market itself, since 2009, more than a dozen VIX futures Exchange Traded Notes (ETNs) have been introduced, allowing retail investors to trade VIX futures through regular brokerage accounts. The ETNs follow simple, pre-specified, dynamic trading programs, and in most cases offer constant maturity exposure to *n*-month futures positions.

The interest in VIX futures and ETNs trading is due at least in part to the perceived positive diversification benefits of the contracts. The CBOE notes through various marketing materials that the VIX correlates negatively with the Standard & Poor's (S&P) 500 returns and therefore provides diversification benefits. The CBOE's own estimates of the VIX-return correlation range from −75% to −86%. Additionally, since the VIX is significantly more volatile than the S&P 500 itself, the VIX, and thus VIX futures, have substantial negative market betas.

The first objective of our paper is to provide descriptive statistics on the average returns to VIX futures positions and the associated ETNs. Szado (2009); Alexander and Korovilas (2012), and Whaley (2013) report negative annualized VIX futures returns. We collect futures data from

☆ We are grateful for comments by the editor, Bill Schwert, and an anonymous referee. We also thank Grigory Vilkov, Mark Ready, Kjell Nyborg, and seminar participants at the European Winter Finance Summit and the University of Wisconsin for useful comments.

* Corresponding author.
E-mail addresses: beraker@bus.wisc.edu (B. Eraker), yue.wu@moodys.com (Y. Wu).

http://dx.doi.org/10.1016/j.jfineco.2017.04.007
0304-405X/© 2017 Published by Elsevier B.V.

January 2006 to May 2013 and confirm these findings. For example, if someone invested in VIX futures in January 2006 and rolled the position at end-of-day futures prices reported by the CBOE, she would have lost more than 97% of the initial investment by the end of March 2013. This corresponds to an annualized return of about −30%. This number is staggering considering that during the first part of the sample period the investor would have more than doubled the initial investment through the peak of the 2008 financial crisis. Not surprisingly, the VIX ETNs perform as badly, if not worse, than the underlying futures. In fact, since the first two VIX ETNs were introduced on January 30, 2009, the VXX and VXZ, which offer exposure to short and medium term futures, respectively, have lost an average of 34 and 14 basis points per day (simple returns).

The second and major objective of our paper is to ask: are the negative average returns consistent with returns from a present value based equilibrium model? Specifically, we use the equilibrium model of Eraker and Wang (2015) to derive equilibrium VIX futures prices. This model is based on a dynamic present value framework where investors discount a distant cash flow using time-varying discount rates. We show that the model produces a sizable volatility risk premium. To understand where this premium is coming from, we detail the main ingredients of the model here.

The large negative return premium to volatility assets in our model is linked to the *volatility feedback effect*. The fact that volatility shocks and stock prices are strongly negatively correlated is well known, and many authors have suggested this is caused by a volatility feedback effect. For example, French et al. (1987) conclude "...we interpret this negative relation as evidence of a positive relation between risk premia and ex ante volatility." Campbell (1991) suggests decomposing realized returns into revisions in expected cash flows and revisions in expected discount rates, or expected rates of return. Any model based on present value computation that has time-varying expected rates of return will, according to Campbell's decomposition, have an endogenous negative correlation between shocks to expected returns and realized returns. Our model implies that expected returns are proportional to a time-varying variance factor. Shocks to this variance factor correlate negatively with returns and the magnitude of the correlation depends on the representative agent's risk aversion.

A primary objective in our analysis is to fully endogenize this negative correlation. To see why this is important, note first that prices of volatility derivatives, such as VIX futures, depend positively on spot volatility. Since volatility negatively correlates with stock prices, volatility claims are negative beta assets. Since volatility claims have negative market beta it is useful to consider a Capital Asset Pricing Model (CAPM) style equilibrium: in order to deliver a large negative premium for volatility assets they would need to be negatively correlated with the market portfolio. Since the prices of volatility derivatives are positive increasing functions of spot market volatility, a key component in generating a negative risk premium is that spot volatility itself is negatively correlated with the market. Our model does this, and our baseline specification generates a volatility-return correlation of −0.61 at the estimated parameter values.

Both diffusive and jump shocks to cash flow volatility are priced in equilibrium and the market price of risk is a function of risk aversion and the "deep" parameters that govern the dynamics of volatility. Rather obviously, the market price of volatility risk depends on the parameters that govern the size of volatility shocks. Also, important to note, it is inversely related to the speed of volatility mean reversion. Intuitively, investors demand a higher risk compensation when shocks to volatility have a longer lasting effect. This is analogous to long run risk models.

The model generates an upward sloping equilibrium futures curve (contango) in steady-state. This means that, ceteris paribus, investors who purchase VIX futures pay more than the value of the spot VIX at expiration of the futures contract, on average. The equilibrium model produces a negative premium in all states of the world, whether or not the VIX is above or below its steady-state value. Even if the futures curve is in backwardation (downward sloping), the futures may imply a negative risk premium because the physical speed of mean reversion will be faster than the Q measure speed of mean reversion implicit in the futures prices. These pricing implications are entirely equilibrium outcomes. If the representative agent in the model is risk neutral, none of these pricing implications hold. In particular, there is no volatility risk premium, the steady-state futures curve is essentially flat, and the expected return on VIX futures is zero.

Our paper is connected to the extant literature in several ways. Our theoretical model is related to long run risk models (Bansal and Yaron, 2004) that deliver large volatility risk premia such as those of Eraker and Shaliastovich (2008) and Drechsler and Yaron (2011). Other theoretical justifications for large volatility risk premia include the heterogeneous beliefs model of Buraschi et al. (2014). Bollerslev et al. (2009); Andersen and Todorov (2013) among others show that the volatility risk premium can predict stock market returns. Eraker (2012) shows that a large volatility risk premium is consistent with large negative equity options returns such as those found empirically in Bondarenko (2003); Bakshi and Kapadia (2003), and Eraker (2013), among others. Broadie et al. (2007) conclude that jump-risk premium, not volatility risk premium, is the primary driver of risk premia in option returns. Recently, Andersen and Todorov (2013) proposed a model with a self-exciting jump process but find that this "tail factor" has no incremental power in predicting equity return above the level of volatility itself. This empirical finding lends support to the specification of models in which jump-risks are not disentangled from the diffusive variance, as in our model.

In our model, jump and volatility risk premia are obtained endogenously and both are increasing in the level of risk aversion. Simplified, if agents are risk averse, they care about the volatility of future cash flows. Their aversion toward high volatility is similar across diffusive and jump driven increments to volatility. Yet, the equilibrium price process we use has characteristics that are similar to existing reduced-form, no-arbitrage models. Our